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Predicting Puberty[1]

CHARLES D. FLORY

GROWING children reach a point in their development when childhood is replaced by reproductive ability. Popular usage considers adolescence as a developmental stage synonymous with the "teen-age." A reference to experimental literature reveals that an arbitrary period of seven "teen-ages" (13 to 19 years inclusive) does not cover the last stage of growth in all individuals. Some children reach puberty and experience the accompanying physiological changes long before age thirteen; other individuals are still pre-pubescent in the late teens and continue to experience significant growth increments beyond their twentieth birthdays. The range of ages at which puberty occurs is approximately from nine to eighteen inclusive for children who are normal mentally. Feebleminded individuals have a very checkered picture in all of their development but on the average are quite late in becoming pubescent. Since the normal age range for puberty is approximately ten years it seems important to give some consideration to means whereby the probable onset of pubertal changes in a given child can be predicted. It is the purpose of this paper to consider certain anthropometric measurements and osseous indices which will predict the age at which a given girl is likely to reach puberty.

Mankind has for centuries past attached considerable significance to the transition from childhood to a more mature stage of development. Primitive peoples built up elaborate ceremonies through which maturing youths were introduced to full social status. It is not quite clear to objective-minded investigators whether adolescence is really a time of "storm and stress" as some writers would have us believe or whether the mystery which has surrounded procreative ability has produced ceremonial celebrations which further complicate the interpretation of the developmental phenomena. Church confirmation, school organization, and social practice have been significantly influenced by supposed transformations which are thought to accompany puberty.

The general attitude of the layman toward adolescence is well illustrated by the girl who wrote in her diary:

> I'm 20 years old this day, and I hate it. Out of my 'teens. 'Teens is such a peach of a word. It makes you think of ten hoodlums in one car going somewhere, telephone calls an hour long, and jazz, and fraternity pins, and kissing people without cause or

[1] This study has resulted from a Research Fellowship in Child Development at the University of Chicago. The fellowship has been provided by the General Education Board.

effect, and being insane over football games because your swootie's playing fullback. Of course, all that lasts over into the 20's a little way, but it's a sort of a hangover then, it seems to me. I know I'll never feel the same again.

As the mystery of sex has been gradually removed by a study of biology some of the so-called "storm and stress" has been eliminated from adolescence. Pubertal changes though still uncharted are nevertheless sufficiently significant to warrant consideration by research workers and practical school people. If techniques can be developed for predicting the probable year in which puberty will occur then those investigations which purport to describe the changes at adolescence can be confined to a much more definite age range in the life of a given child.

THE SUBJECTS

The cumulative records system of the University of Chicago Laboratory Schools has been in operation for a sufficient time to provide data for a number of subjects over a ten-year period. Eighty girls, who had quite complete records, were selected as subjects for this investigation. Anthropometric measurements had been made on each subject on or very near her birthday. All of the subjects considered had an X-ray of the right hand at yearly intervals. A complete physical examination made annually near the child's birthday provided an opportunity to obtain data concerning pubertal development. It was possible from these records to construct a relatively complete picture of the child's physical development.

Girls were selected as subjects for this study for two reasons. First, the date of first menstruation used as a criterion of puberty among girls has no comparable counterpart among boys. Second, the number of girls with consecutive records exceeds by far the number of boys with equally complete records.

Each subject had entered the University of Chicago Laboratory Schools several years before the onset of pubescence. Data were therefore available before, at the time of, and after the occurrence of puberty. At some ages and for two of the predictors considered later in this paper fewer than fifty of the eighty subjects had complete records. It will be possible in future years, as evidence continues to accumulate, to use a larger body of data and thereby obtain more stable correlations for the several predictors to be considered.

Predictors

Anthropometric measurements. Anthropometry has long found favor in child development centers. Techniques have been refined so that measurements can be made with high reliability. How well do these physical measurements predict the onset of pubescence? Height and weight will be omitted from this discussion since many other investigators have dealt with these two measures.

It may seem improbable that head size would have any relation to puberty but several correlations were computed to support or disprove the general opinion. Since head size has nearly completed its growth before puberty occurs it was felt that age nine should

be used to compare the relationship between head dimensions and puberty. Head length at age nine correlated .10 ±.11 with first menstruation, while head width correlated .20 ± .11 with the same criterion.[2] It is of some significance that both of these correlations go in the same direction but one would certainly not continue to measure heads merely for the sake of predicting puberty.

Changes in chest dimensions with the onset of pubescence would lead one to suspect that there is a relationship between chest measurements and puberty. If a measure is to be used for predictive purposes it needs to be taken before the occurrence of the event to be predicted. Chest measurements at age twelve, approximately one year before the average age for first menstruation, show the following correlations: .26 ±.08, .34 ±.08, and .46 ±.07 for girth, depth, and width respectively with the criterion for puberty. Lung capacity at age twelve which is somewhat related to chest size correlates .32 ±.08 with first menstruation. All measurements of chest dimensions are related[3] to puberty but it is clear that chest width has the best predictive value, if the age at which puberty will occur is the desired prediction. Lung capacity is about equal to chest depth as a predictor of puberty. It is possible that chest width can be determined more accurately than other chest measurements but it is interesting to note that head width was more closely related to puberty than head length. It is not quite clear why widths should be better predictors than volume, lengths, heights, or girths. Neither head nor chest dimensions are highly valuable as predictors of puberty though chest measurements have a closer relationship to first menstruation than head size.

Hip measurements have been thought to be closely associated with puberty. That pre-pubescent girls differ from post-pubescent girls in hip dimensions can not be denied but a mere increase in size with age does not necessarily mean a good predictor of puberty. Iliac and trochanter widths at age twelve correlate .57 ±.06 and .58 ±.06 respectively with first menstruation.[4] Iliac width is considered the more accurate hip measure but it is no better predictor of puberty than trochanter width. At age nine iliac and trochanter width correlate .41 ±.10 and .37 ±.10 respectively with puberty. It is significant to note that hip measurements at age nine will predict puberty nearly as well as the best chest measurement at age twelve. While chest dimensions are better predictors of puberty than head measurements, hip widths are superior to the best chest measurement as a predictor of first menstruation.

[2] These correlations will be positive or negative depending upon the arrangement of the scale. Head size and age at which first menstruation occurs are really negatively associated, i.e. the larger headed children reach puberty at the earliest age. These coefficients have been made positive by inverting the scale on one axis of the correlation sheet.

[3] Previous note on the sign of the coefficient applies.

[4] Again the coefficients have been made positive by arranging the scale. Large hip size goes with early puberty.

Although correlations of the magnitude found from anthropometric measurements can not be disregarded as predictors of puberty, one would not be content to make predictions from measurements which are a mere 15 or 20 per cent improvement over chance. Any correlation below .60 has a predictability which is less than 20 per cent better than a guess. Anthropometric measurements taken singly do not seem to fill the need as predictors of puberty.

A combination of several dimensions was even less suggestive than the straight correlations reported above. A sum of three head dimensions, height, length, and width, correlated .22 ±.11 with first menstruation. Head width is practically as good as a combination of these three head measurements. Iliac width divided by trochanter width correlated only .22 ±.10 with puberty, which is much lower than either measure taken singly. The sum of chest width, iliac and trochanter widths correlated .46 ±.08 with first menstruation but chest width alone is as good as the three taken together. Iliac width plus chest width correlated .48 ±.08 with puberty but this combination is less desirable than iliac width alone. Some combination of or ratio between anthropometric measurements may eventually be found which will predict puberty better than single measurements, but the present investigation turns to other predictors of first menstruation.

Osseous development. Early investigators who made use of X-ray techniques to determine the degree of skeletal development had hopes that anatomical age might eventually replace chronological age as an index of the stage of maturity. Relationships between ossification and intelligence, ossification and school progress, and ossification and anthropometric measurements have been widely studied. Some attempts have been made to relate skeletal development to the physiological development signified by puberty. But very little detailed work has been done in this latter field of investigation.

The ossification ratio as devised by Carter (1) is one of the well known measures of skeletal development. Ossification ratios at age eleven correlate .30 ±.07 with first menstruation.[5] Although this coefficient is low it suggests a possible relationship between osseous processes and puberty. The writer has in preparation a scale whereby the osseous development of a given child can be determined in skeletal months values. Thus an eleven-year-old child who is retarded one year would have a rating of 120 skeletal months, whereas a child of the same age who is accelerated one year would have a rating of 144 skeletal months. Skeletal months ratings which were made for a group of eleven-year-old girls correlate .64 ±.05 with first menstruation. This value is the highest relationship thus far reported between osseous development and puberty when age is held constant.

Some writers have contended that bone appearance is of little value in determining the degree of osseous

[5] These coefficients have been made positive by arranging the scale as was done with anthropometric measurements.

development. The age at which the pisiforme appears correlated .53 ± .07 with first menstruation. This bone, the last of the carpals to appear, has a definite relationship with puberty. The writer observed that girls who reached puberty early had sesamoid bones at an early age. It was found that the sesamoid at the distal end of the first metacarpal, which is present in all mature individuals, is always present before a girl menstruates. There is therefore some relationship between the appearance of this sesamoid and puberty. The degree of relationship was found to be expressed by a correlation coefficient of .76 ±.04. This one point on the X-ray of the hand which can be determined quite objectively and with little or no training in roentgenology has a higher predictive value than either anthropometric measurements or skeletal evaluations. The sesamoid at the distal end of the first metacarpal appears on the average at age eleven or about two years prior to puberty.

It may appear on the face of these data that the appearance of the sesamoid is a better predictor than other measures of osseous development. Skeletal months ratings at eleven years of age correlated .64 ±.05 with puberty when age was held constant, while sesamoid appearance usually has a wide age range. No prediction can be made from the absence of the sesamoid except that puberty has not yet been reached and is not likely to be reached within the following year. The age range for the appearance of the sesamoid is approximately nine to thirteen years of age or a five year period. Skeletal months ratings which hold age constant and give an evaluation at any age have advantages over a single point such as the appearance of a sesamoid. The simplicity and objectivity with which sesamoid appearance can be determined add to the value of this predictor of puberty.

Further investigation shows that no girl has reached puberty whose ossification ratio is below 1.00. Though ossification ratios correlate low with first menstruation this critical point, when the area of the bone shadows exceeds the area of the carpal quadrilateral as defined by Carter, seems to be of some value. No girl has a ratio below 1.00 if the sesamoid on the distal end of the first metacarpal is present. On the other hand, if a girl whose X-ray reveals the presence of the sesamoid has not reached puberty one can be relatively certain that the first menstruation will occur within the next twenty-four months. These facts from osseous development suggest that there is a closer relationship between osseous development and pubertal development than there is between anthropometric development and the date of the first menstruation.

CONCLUSIONS

Cumulative data reveal that puberty is an event which is related to physical size and osseous development. While any physical dimension seems to have some relationship to the onset of pubescence, it is quite clear that head measurements are less valuable than chest measurements and hip widths are more valuable than chest dimensions as predictors of first menstruation. Osseous development seems to be more closely related to puberty

than is physical size. Skeletal months ratings are better predictors of first menstruation than any anthropometric measurement considered in this study. The time of the appearance of the sesamoid on the distal end of the first metacarpal is the simplest and best single predictor of puberty in girls. No girl has menstruated whose ossification ratio is below 1.00 or whose X-ray of the hand shows the absence of the sesamoid at the distal end of the first metacarpal. Sesamoid appearance usually precedes puberty by about two years. A further accumulation of data may give more definite support to these tentative conclusions.

REFERENCE

(1) FREEMAN, FRANK N., and CARTER, T. M.: A new measure of the development of the carpal bones and its relationship to physique and mental development. Journal of Educational Psychology, May, 1924, 15, 257–70.

The Problem of Child Development[1]

L. K. Frank

THIS paper is an attempt to state the problem of *child development* as a focus for scientific research and to set forth somewhat briefly the methods which initially may be employed in its study. Finally, an effort will be made to indicate the significance of this problem and its relation to various scientific enterprises in the field of medicine, psychiatry, and hygiene.

I

In general, child research is primarily directed by the current problems and preoccupations of the several branches of life science which utilize the child as a convenient and significant subject for investigation and experiment on those professional problems. It must be evident, however, that the human child, as a *developing organism with a prolonged infancy*, may be approached as a subject of scientific inquiry giving rise to problems which are in many ways peculiar to themselves, calling for a formulation and methods of study distinguishable from the various enterprises in child research just described. It is from this direction that the problem of child development arises and merits our attention. The emergence of this problem of child development is itself not without significance for our discussion, since it may be said to express the far-reaching shift in scientific conceptions which is now under way. Perhaps the simplest way of indicating this shift is to refer to the increasing interest in and discussion of what has been called the "organic" or "organismal conception" or the "organism as a whole." The consideration of these topics and the attempts to formulate these conceptions with increasing precision are, in the writer's opinion, no unique creations without antecedent preparation. Rather it would seem that the very success with which the various branches of the life sciences have pursued their inquiries has made this development inevitable. For a generation or two scientific workers in the different fields of work have been preoccupied with the laborious task of perfecting methods for the collection, recording, and measurement of the different kinds of data which a growing organism may yield. Such studies must by their very nature be restricted in their scope and confined to the discovery of the relation between

[1] Presented to the First Biennial Meeting of the Society for Research in Child Development, Washington, D. C., November 3 and 4, 1934. An earlier statement of the point of view and formulation of this paper was given at the Washington Conference on Child Development, May 1927 (see Proceedings of Conference, Committee on Child Development, National Research Council).

data and the structure or activity from which those data proceed. It is, therefore, permissible to view the rise of this interest in the total organism as a more or less inevitable development of these preceding studies, because we have arrived at a point where these basic and fundamental inquiries have yielded results of astonishing character in the shape of reliable methods and verified data for the study of structures and functions of organisms. Thus, having achieved many of the threshold tasks of biological science, investigators of a more inquiring mind have begun to ask themselves what significance inheres among these verified data and how far has the very abstraction characteristic of this preparatory work served as a barrier to the understanding of those processes which are carried on within the organism as an integrated and interdependent whole.

Concurrently with these questionings and speculations, there have been repeated cases in which investigators, intent upon the study of a discrete problem, have found, to their amazement and chagrin, that their carefully elicited data were either incomprehensible or unusable because the organisms from which those data had been obtained were, apart from the two variables measured, unknown and ununderstandable.

II

We may say that growth and development are the changes in magnitude and configurations occurring during the life career of an organism as exhibited in its developing structures and functions as well as in its total overt activity as it moves toward maturity. These changing magnitudes may take place either through constant increments or decrements, giving a smooth line, or through cycles of increments followed by decrements wherein the successive advances overbalance the successive recessions, or vice versa, in the sequence of oscillations. Development as herein used implies decrease or involution in structure and function as well as increase.

The human infant at birth is viable but not complete in structure and function nor physiologically organized, and so must grow to completeness and achieve maturity both structurally and functionally during its prolonged infancy, as the following quotation from Walzen (5) indicates:

> "The baby at birth is physiologically incomplete and this manifests itself in all parts of the body through instability or irregularity or lack of function. How this incompleteness passes over into the steady functioning of the normal adult, or perhaps fails to do so in the abnormal adult, is a field of investigation largely untouched and yet one which has a vital bearing on the proper understanding of the young child."

Since there cannot be a function without a structure nor a structure without a function, development implies concomitant changes in structures and functions. The fluctuations or oscillations in magnitude, *e.g.*, in intensity or duration or extension, which take place during growth may be regarded as essential in the growth process, since any fixity of function or process or of structure would interfere with, if it did not frustrate, growth changes. Growth and stability are not compatible, since organs must

continue to function while growing. For example, growth of the stomach occurs through changes in the upper and lower limits of expansion and contraction as it functions daily; the range of distension is gradually enlarged through these oscillations in the functioning organ.

Growth or development may, therefore, be regarded as the secular trend arising from or generated by these oscillations or cyclical fluctuations of structure and function. To the extent that these oscillations or cycles, when plotted, present their concave sides in opposition, we may, as suggested by Dr. Ragnar Frisch, conceive of an individual norm around which the fluctuations take place, this norm being the line of secular trend or organic growth for that fluctuating structure or function.

If the conception of an organism or of organic unity be valid, then it is probable that these oscillations and fluctuations in the structure and functions or processes of the growing child are interrelated. To put it another way, the magnitude of change of structure or function in the growing organism at any moment is related to the magnitude of all other structure and functions in that organism with greater or less immediacy, from which it follows that any perturbation within the organism will be transmitted with greater or less effect and *with varying lags* through the whole of the organism. This latter point is expressed in the general conception of compensation or internal adjustment as illustrated by the work of L. J. Henderson and of D. D. Van Slyke on the respiratory cycle and of W. B. Cannon on homeostasis.

III

Each of the changing structures and functions of the growing organism yields, or may be made to yield, data which reveal directly or indirectly what is taking place therein. Consequently, the growth and development of a child may be studied through the application of all relevant scientific techniques to the individual child and the collection thereby of the various data indicating these changes in the structures and functions of that child.

The foregoing leads us directly to the problem of child development which we may state as the problem of discovering the rate and direction of change in the structures and functions of the child and of revealing the interrelationships existing among the several structures, functions, processes, and activities as disclosed by their appropriate data. These several classes of data may be distinguished as falling into two classes: (1) structural characteristics which are revealed in the changing magnitudes of the total organism and of its various systems and parts, recorded and measured primarily in physical terms, *e.g.*, mass and extension; (2) functional activities divided into, (a) endogenous or internal processes, and (b) overt activities, which are revealed in the changing spatial configurations and energy transformations that constitute the function or activity. Recalling that the human infant is at birth incomplete in structure and function

and not yet integrated, we may see that the maturity of the human organism involves the attainment to a more or less "steady state," as contrasted with the instability found in the infant and the child. This task of achieving maturity, both structurally and functionally, states the problem of child development and indicates the technique for its study. Essentially, the task is to record and measure as many as possible of the changes taking place in the growing child and to ascertain what, if any, sequences are discoverable among the changing magnitudes of the several structures and functions. Having recorded and measured these changes, it then is appropriate to inquire whether the magnitude of the fluctuations shows any change over a period, *i.e.*, whether as the child grows older the magnitude of the fluctuations decreases (or increases) as the child approaches the "steady state" of maturity. Again, it is necessary to calculate the line of secular trend for each of these fluctuating structures and functions in order to discover the rate and direction of change of that structure or function so that its movement toward maturity may be studied both as a process having presumably, a law of its own, and as a member in a series of concomitant changes, the rates of which will be related one to the others. Finally, it is important to discover from these different series of data from each individual child what is the order of development among these changing structures and functions and activities, thereby revealing the accelerations and retardations, the precocities and infantilisms within the growing child. This order or sequence of development offers the clue to the understanding of the individualized child who is engaged in working out a method of living, growing, learning, and otherwise functioning within the limitations of these different maturities. It is precisely this highly individualized organic condition of varying rates of development which gives rise to the unique, idiosyncratic individual with his peculiar personality, idiomatic functioning and differentiated structures.

If we reflect upon the methodological principles and techniques involved in the foregoing, we will see that they call for, first, the application of the various scientific techniques and measures to the individual growing child and the discovery of the significant intervals for which successive determinations of each structural and functional change must be made. That is to say, for each of the structures and functions of the growing child as revealed by known or to-be-discovered techniques of measurement, we must determine how frequently measurements must be taken in order to reveal the rhythm of fluctuation either as a recurrent process of a short period or as a process with a long-term period of frequency. Having determined then how frequently these measures must be made, the data thus obtained must be analyzed and plotted for each individual child separately in order to reveal the fluctuations in the structures and processes of the individual thus measured. Herein the techniques developed for the analysis of time series, especially as they have been worked out for economic data in the study of business cycles, may

be found highly valuable and appropriate, since the manipulation of these data calls for the measurement of the magnitude of the fluctuations in each set of data and for the calculation of the line of secular trend which those fluctuations generate. To illustrate by a concrete example, if a daily record is taken of the number of hours an infant is awake in each twenty-four hour period, we would have a series of records showing the fluctuations from day to day in the total number of hours awake, with a gradual increase in the number of waking hours as the child grows older. The manipulation of the raw data through known techniques would show how far the magnitude of the fluctuations was changing from day to day, and would also give the line of secular trend indicating the child's gradual relinquishment of sleep and assumption of wakefulness during the day, through daily variations that have a trend downward.

Therefore, in so far as the data on the various structures and functions of the child were calculated and plotted, we would have available for that child a series of curves showing the cyclical fluctuations and the gradual changes in the upper and lower limits of those fluctuations over a period, together with the lines indicating the resultant changes and magnitudes of structure and function arising out of these fluctuations. It is submitted that the changes in the magnitude of these fluctuations is indicative of the organism's approach to the "steady state" of maturity and that the line of secular trend traces the organism's achievement of those magnitudes, structures, and functions which are characteristic of the adult state and to some extent before puberty.

It is to be noted, however, that our assumption that these functions are interrelated because they are exhibited by the unified organism makes it impossible to consider any one of these curves as an isolated event; rather we are forced to consider the development of the child as taking place through a number of interdependent events, *no one of which can be segregated, except for purposes of measurement*, and no one of which can be understood or interpreted without taking into account the concomitant events of the total organism. From this it follows that any undue perturbation in the magnitude of these fluctuations or any shift in the line of secular trend which they reveal is to be regarded as an indication of a total organic change of which we may expect to find indications of greater or less degree of sensitivity in all the other data collected from that organism, *but with varying degrees of lag*. Here we must be on our guard against assuming that either the fluctuations or the growth curves of structures and functions will be correlated since it is unlikely that, in an incompletely organized individual such as a growing child, anything will be correlated for long.

It will be seen from the foregoing that we may at once address ourselves, through such analyses of the various data, to the study of what is taking place in the growth process of the total organism and thereby obtain possible clues to the puzzling features of the present study of the isolated structures and functions in the child.

Significant both for scientific research and for child welfare, the study of the magnitude of the fluctuations in the various structures and functions of the child might lead to the discovery of the range or amplitude of fluctuations that is compatible with wholesome growth and development. Moreover, the study of the changes in the amplitude of these fluctuations, and of the various growth curves they generate, during the period of growth to maturity would indicate whether any particular structure or function was failing to mature concomitantly with the others, and would thereby show that the various kinds of defects discoverable in children are essentially symptoms or evidences of the failure of the growing child to maintain a coördinated rate of change in all of the various growth processes involved in the maturation of the organism. From this we might infer that any lag or retardation in the growth of structure or process would of necessity become cumulative with advancing years and it is evident from the available clinical material that we do have all manner of retardations and precocities in children. By assuming that normal development implies not absolute coördination in the changing structures and functions but rather a sequence based upon the relative rates of change appropriate to each structure and function, we may approach the problem of normal development not as the establishment of statistical norms for chronological age or fixed dimensions that all children should attain at any year or incident of time, but rather as the delineation of the secular trends in the growth of each of the structures and functions calculated for each individual child from the fluctuating data he yields. Such a conception of normal development would yield essentially dynamic norms and would lead us to study the coördinations and discrepancies in the various lines of secular trend that might be calculated for each child.

One promising approach to the study of individual child development is the systematic study of the placement rank or order of different characteristics of a child at frequent intervals. It is evident that with respect to his contemporaries, a child will occupy various placement ranks or orders that will change from year to year and that these changes in themselves are significant of how that child as an individual is developing. This would be revealed in the changing rank or order for each characteristic and in the changing profile of all these changing placements (3).

The study of child development along these lines would probably show that at different epochs in the child's career there were different centers of dominance; *i.e.*, different structures and processes would be changing more rapidly than others, as revealed by greater amplitude of fluctuation and more sharply sloping lines of secular trend. Thus, during the life of the child we should expect to find a structure or a function increasing or decreasing up to a certain point where it would remain stationary, not only relatively but absolutely, while the lagging structures and functions caught up with this more precocious factor, as it were.

We would expect to find in the

growth of the child, and we do find, nodes which, from this point of view, may be interpreted as occasions when the secular trend of the different structures and functions are fairly coördinated. Undoubtedly, in so complex an organism as man, there may be various centers of dominance since the phylogenetic record indicates the probability that man as an organism arose by confederation as well as by conquest so that we find certain systems and structures participating in the total organism but nevertheless retaining a degree of independence, reminders of their one-time freedom from organic domination. Here we may refer to smooth muscle and the vegetative nervous system which retains so large a measure of independence, as indicated by the name—autonomic nervous system.

It is appropriate here to point out two apparently divergent trends in development of the human infant. In activities of overt behavior, such as motor activities, the developmental sequence appears to move from total organic, all-over type of activity toward progressive differentiation of activity and subsequent integration, as seen in acquisition of skilled patterns of prehension and so on. While there are many unsolved questions here, the general movement seems to be that indicated, wherein bodily segments emerge as capable of separate activity from a previous organic complex.

In functional activity the reverse movement appears to obtain. The infant begins life with a number of physiological processes operating with relative independence of rate, efficiency and outcome, so that development brings a progressive coördination of these organ systems into a functioning whole.

Individual development may therefore be viewed as occurring through a progressive resolution of these divergent, if not conflicting, processes. Integration, in the light of this discussion, may be conceived as the goal of child development, within the limits which the current state of development of organic unity makes possible. Integration must be regarded, therefore, not as a movement toward static coördination and normative adjustments, but emphatically as a movement toward organic differentiation and coördination whereby structural and functional autonomy yields to an integration appropriate *for that organism*. The molding of structures and the modification of functional processes and activities may then be regarded as coming about through interaction among these fluctuating magnitudes which sooner or later culminate in the attainment of a dimension in mass or extension or in a range of fluctuations which is a function, mathematically, of the total organic situation. During the period of growth of the organism, there may be a struggle for domination among the various structures and processes, which struggle is revealed in these fluctuations as the different systems are gradually brought into a coördinated interrelationship among themselves. The large initial fluctuations in the infant reveal this lack of organic unity and coördination and dramatically portray the competition of the several processes and functions for the maintenance of their independence. Again in adolescence we see

instability of functional activity as growth takes place. But in later adolescence, these wide fluctuations gradually subside as the several structures and processes increasingly participate in the total organic complex and are brought under the governance of whatever dominant structures and processes manage to obtain dominance during the movement toward maturity.

IV

The individual personality may be regarded as the product of inheritance and of this developmental process wherein the idiosyncrasies of the individual organism's integration have become cumulative with growth to maturity. At the present moment, we are becoming increasingly concerned with the study of personality and with the investigation of constitutions and types. For the most part, these studies are attempts to elicit from the records of mature, adult individuals certain categories or groupings among which different individuals may be classified, or attempts to correlate physical measurements with certain traits or characteristics. It is believed that the study of child development along the lines herein indicated offers a more fruitful method of attack upon this problem since it is evident that any distinguishing characteristics of personality or of constitution must at some time in the career of the individual begin to appear, perhaps with a scarcely noticeable degree of difference from the other factors in the organisms but destined to assume an ever-increasing magnitude. To illustrate, through the work of Kretschmer and Van Horst in Germany and of George Draper, Stockard, and others in the United States, attention has been directed to the long-thin, or asthenic type, and the short-fat, or pyknic constitution or type, and the apparent susceptibility of the long-thin type to gastric ulcer and schyzoid personality, and of the short-fat type to gall-bladder disease and cycloid personality. It is submitted that these proposed constitutions or types represent the end results of processes which start during the development of the child.

It is important here to consider the probability that the differential rates of growth in the child and youth may generate these conditions of disease and susceptibility as organic liabilities arising from discrepancies in the rates of growth. Thus, one adult form may be indistinguishable from other adults because there is no clear-cut differential or sharply defined bi-modal or tri-modal distribution. Nevertheless, the growth processes in the adult individual found at one extreme of a frequency distribution may have been quite different from those individuals found in the center or at the other extreme. This suggests the possibility that constitutional types may be delineated by the genetic method of studying the development of the individual child to maturity, seeing in the differential growth of structures, functions, and activities of each child the *process of constitutional organization*. Thus, the inability of investigators to establish types in adult subjects leaves open the possibility of identifying growth types of even greater significance and clinical utility. To

illustrate, two individuals may at adult age show relatively minor differences in bodily dimensions so that in an adequate sample of adults those differences are not significant of valid differences. Nevertheless, one adult may have reached those dimensions at fourteen to sixteen years of age (the so-called anthropoid growth pattern), while the other may have approached his adult stature and girth by a leisurely development over four to six years. Obviously, the first individual may have been exposed to all manner of stresses, strains, and maladjustments by reason of this accelerated growth in stature and possibly retarded growth in functional efficiency (*e.g.*, heart, gonads, et cetera), while the other, slowly growing adult may have escaped such distortions and asymmetries. Without this genetic picture of their development, we cannot hope to distinguish constitutional types or begin to understand how mental and physical diseases are characteristic to different kinds of individuals whom we can identify clinically but not establish statistically. Moreover, we cannot interpret our clinical findings on individuals by reference to age norms, since each individual organism is an aggregate of maturities only rarely coincident with chronological age. What is of real significance is *the individual's own range of variability* or *fluctuations in functional processes, susceptibilities and immunities;* if he exhibits swings or perturbations of unusual degree in one function and greater or lesser swings in other functions, this condition of organic incongruity may be of greatest significance although he shows no pronounced deviations of single functions from so-called norms. This is clearly shown by the studies of R. G. Hoskins and associates on schizophrenics at Worcester State Hospital where few significant deviations from clinical norms of single functional activities have been found, but where the individual exhibits pronounced idiosyncrasies in individual functional activities and in his total organic functioning, characterized by Hoskins as "physiological clumsiness." Such individuals may be regarded as having failed to achieve organic efficiency due no doubt to circumstances of the growth processes wherein hereditary factors may be of large import.

The problem of identifying constitutional types is therefore to be viewed as a *genetic problem* of discovering the divergent paths followed to maturity by different individuals who at maturity may defy segregation into types upon the basis of end-products or dimensions but who carry within their organic constitution the consequences of their idiomatic growth and possibly skewed development.

The development of the individual personality as arising from this process of discrepant growth offers large possibilities for study. Instead of attempting to measure personality directly, we can delineate personality development as a derivative of these primary, measurable changes, a way of integrating these skewed and asymmetrical processes and structures and their interrelations within the socially sanctioned patterns of culture (4).

The foregoing indicates that by studying child development through the intensive investigation of the vari-

ous structural and functional changes we may approach delineations of personalities, constitutions, and types with much more promise of understanding their evolution than in the statistical study of large numbers of adults exhibiting end results of these changes. Moreover, it indicates a manner whereby we may genetically approach the delineation of the four panels suggested by Draper—namely, anatomical, physiological, immunological, and psychological—and discover the interrelationships as the differing expression of varying processes of organic development.

One of the obstacles to the study of child development as here conceived is the preoccupation of the participating sciences with the problem of the relation of two variables as measured at one instant of time and the problem of causation (2). These preoccupations have led to a neglect of the concept of time and methods for analyzing time series. Also they have discouraged efforts to analyze data obtained by different disciplines from the same child, as violating scientific canons.

Time is generally conceived as a variable, but it is also a process; that is to say, physiological time is a process of irreversible change that is of critical importance in study of child development. As Dr. Carrel has pointed out physiological time (1) is in the organism and it differs from physical or sideral time in not having a constant rate. As the time process is observed in organisms, it appears in the operation of all physiological functions, giving them a different character as the duration of the organism increases. The neglect of time in our thinking and research work is evident in the lack of any clear-out conceptions of physiological development of an organism; it cannot be measured merely in increase of magnitudes as we are accustomed to think in structural development. Thus we must consider physiological development in other terms, such as increase in functional efficiency (*i.e.*, chemical efficiency of secretions per unit of time or substance) or as stabilization of functional activity or perhaps as coördination and integration of one functional process with other functional processes. The concept of maturation of function offers a promising lead here.

The conception of time is, as suggested, critical for our formulation of the problem since we may, by misconceiving time, create artificial problems that can never be solved, as so often has happened in scientific work. An example of this is seen in the assumption so frequently made in child research that a period of time, day, week, month, or year, is a constant for every stage of child development and that children of the same age are a homogeneous class. These differences in the value and meaning of duration for each stage of organic growth are the very essence of what we call development as distinguished from growth measured in terms of increments per unit of physical time. Dr. Carrel says each human being constitutes a relatively independent world in a state of continuous transformation. It is the rate of this transformation that can be assumed to characterize our specific duration.

From this point of view the problem

of child welfare may be viewed as the discovery of a technique for child care whereby we may try to synchronize the various changes through which the child must pass on his way to adulthood so that he may achieve maturity with the least amount of asymmetrical and uncoördinated development. It may be pointed out in passing that for the most part of our notions of child hygiene are by-products of diagnostic and therapeutic work, and thus far we have little experimental basis for child hygiene. Approaching the problem of child hygiene and child welfare with this concept of development and along these suggested lines of procedure, we see that there is presented an extraordinarily rich and unexplored field of experimentation—namely, to discover and to work out into practicable form the techniques of child care suitable to each of the varying classes or types of children and adapted to the varying needs and requirements of the different periods of the child's development. As suggested before, we may regard the human infant as a relatively unorganized and unsteady aggregation of changing structure and functions which must, if the child is to survive, be brought into some sort of organic unity. We may, therefore, view the development of the child to the prepubertal age as essentially a movement toward relative stability. The onset of puberty then may be regarded as the breakdown of this painfully achieved stability as necessary to adolescent growth. Immediately the problem of adolescence may be stated in this wise: to discover the order or sequence in which structures and processes undergo the pubertal modifications and disturbances with the probability that we can find certain constitutional types or large groupings of individuals for whom this pubertal breakdown and subsequent integration always takes place in the same manner. Then we are faced with the question of whether for each of these types there may not be a more or less fixed sequence of increasing instability in the sense that the initial "break" may take place in one function or structure and be followed by successive breaks in other functions as a patterned sequence peculiar to each constitutional type. Pursuing this notion further, the movement from puberty to maturity may then be viewed as the achievement of the "steady state" of maturity by the progressive stabilization of processes and functions in a sequential pattern peculiar to the constitutional type under which each individual adolescent would be classed, remembering that all manner of retardations are, so to speak, frozen in maturity—*e.g.*, bone growth. Under such a conception, we might envisage a coördinated attack upon the problem of adolescence as has been suggested in the study of the infant and the younger child, and again we might anticipate the development of a technique of hygiene for the adolescent based upon the discovery of these constitutional differences and the application of methods which might help the adolescent to achieve health and sanity in maturity in accordance with the needs and capacities of his own organic situation. It seems evident that if we are to have anything in the nature of preventive medicine, we must look forward to an increasing recognition

of the individual's variability and his peculiar needs and requirements for the achievement and maintenance of sanity and of health. The study of child development along these lines as essentially the genetic branch of human biology, is, therefore, offered both as a program of fundamental scientific importance and as an outline for larger social welfare of an importance sufficient to justify this rather extended discussion.

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A Study of the Speech of Eight Bilingual Children of the Same Family

MADORAH E. SMITH

IN A study of height and weight in three generations, use was made of the diary records kept by Mrs. F. M. Smith of the development of her eight children (1). These records also contained considerable data relative to the learning of language by the children. As all of the children were born in China and,—except for one year in America when their parents were on furlough,—lived there until the youngest child was almost twenty months old, during which time they were exposed to and used two languages, it seemed worth while to study the records carefully to see if they would throw any light on the linguistic development of bilingual children.

These records had been kept from the time of the birth of the eldest child until after the removal of the family to America; but unfortunately are rather scanty before the eldest child's third birthday and after the move to America. The portions of the record relating to speech consist of comments on the children's progress, lists of words known at about a year old, age of first real words used, and quotations of the children's remarks and questions that for different reasons interested the mother and seemed worthwhile recording. The quotations listed before the children were four-and-a-half years old numbered about four hundred and fifty sentences and almost twenty-five hundred words. This made possible a numerical analysis of the sentences at different age levels. As there was no consistency in recording sentences other than the interest aroused by the child's remarks and the mother's opportunity and leisure to do so, the assumption is that the samples are of the child's best attempts and the data are not therefore comparable to other studies where the records have been made more systematically. However it is possible to compare one child with another as the selection of samples was subject to the same factors for the different children. Such comparisons make it possible to consider the effect of certain factors which affected the children differently; for the ages of the children at the time of furlough and removal to America varied and there was a difference the mother states in her own use of Chinese with the older and younger children.

The children while in China heard Chinese always from their native nurses, the other servants and from practically all the Chinese, whether children or adult, with whom they came in contact. They heard English almost entirely from all their adult and child white acquaintances, it was the

language preferred for use among themselves after differentiation between the two languages had occurred; and, in the case of the older children, was the language primarily spoken to them by their parents. But in the case of the younger children, the mother left more of their care to the native nurses while she engaged in mission work and the instruction of the older children. She and the father also used Chinese much more in speaking to the children after their return from furlough. It may be seen therefore that there was a difference in the source of the two languages as heard by the older and the younger children; for the former, the two sources were quite distinct, English from all the whites in their environment, and Chinese from all the natives in their environment; while for the latter there was no pure source of English as their parents used either language in speaking to them and there were always one or two children a little older who were still somewhat confused in their use of the two languages. This difference might well lead to increasing the infant's difficulty in learning to distinguish English and Chinese.

In order to make the analysis of the records as objective as possible, the sentences were analyzed according to 5 criteria; sentence length, number of errors per hundred words, number of inflected forms of English words in proportion to the total number of English words used, the percentage of mixed sentences, by which is meant those sentences containing words other than proper nouns from both languages, and finally the percentage of Chinese words used. The material was separated according to the age of the child at time of record, all sentences spoken between the ages of 21 months 0 days and 26 months 29 days being counted as spoken at 24 months and so on for each six-month interval. In order to isolate the factors operating on the children to a different extent, the material was considered separately for the three oldest and five youngest children and also for each of the three children who moved from a bilingual environment to a monolingual environment or vice versa before they were past three years old.

Sentence length and number of errors per hundred words have been used in previous studies (2, 3, 4, 6) as criteria of progress in speech; and give consistent results in the present analysis, even though the samples when so subdivided are small. Sentence length increases regularly with age for each child or group separately studied and the number of errors per hundred words shows a decrease at each age level in the larger groups and at only one level in each of three of the remaining four groupings is there an increase instead of decrease with age. The increase is probably due to the smallness of the samplings. These 2 criteria treated Chinese and English words, sentences and errors exactly the same.

The third criterion that of ability to use correctly inflected forms also gives quite consistent results after two years old. It is not a very satisfactory measure especially with small samples at that age as the baby's frequent use of a few words learned in an inflected rather than a root form; e g., "gone" hardly indicate knowledge of the use of inflections and yet by the method of count-

ing used would give the child a score. Chinese inflections are so different that they were considered separately. There was no progress shown in such use by a comparable measure but the Chinese samples were too small when subdivided by age to be considered except in the case of the younger boys for whom percentages calculated for their Chinese words as had been for the English words gave scores of 8, 6 and 8 per cent at eighteen, twenty-four and thirty months old respectively.

The percentage of mixed sentences is a useful measure of the confusion of the children between the two languages and shows regular decrease with age. The proportion of Chinese words at the earlier ages reflects the child's comparative knowledge of the two languages but at the later ages it measures rather the proportion of Chinese words still used when the child was trying to speak English for there is only one sentence primarily in Chinese recorded as spoken after a child's third birthday. This probably reflects both the mother's preference in keeping her records in English and the children's tendency to use English in speaking to their mother.

Table 1 gives the results of this numerical analysis. The mother's comments agree in every case with it. Thus she reports M.'s slow progress in speech before her second birthday, that E. whose record is included with the younger boys was by far the slowest of all her children in learning to talk, and remarks on the high percentage of Chinese used by the younger children during their second and third years.

The order of birth of the children was first the two elder daughters, next J., then M. then the three younger boys, of whom E. was the last and then the youngest girl H.

Considering the factors that affected the children differently, the first comparison may be made between the older and younger children. It will be noted that at every age level the older children excel the younger children by all criteria; with one exception, inflections at two years. They use longer sentences, make fewer errors, make greater use of inflections, and use fewer mixed sentences except at three-and-a-half years where very few are used. The average age of end of true confusion is earlier for them also although the age of last mixed sentence is about the same. But these last mixed sentences hardly show confusion of the two languages as the earlier mixed sentences do for with but one exception (E.'s), each contains but one Chinese word which are either words for which there is no true English equivalent or words which, for some special reason, the children had been taught to use instead of the corresponding English word. Words of the first class occurring in these last sentences are "mei-mei" or "younger sister" and "koo-koo" or "elder brother"; of the second class are "du-bi" or belly "sz-poo" or diaper. The children were encouraged to use Chinese words to refer to portions of anatomy, calls of nature and articles of clothing tabooed in polite conversation in English in the nineties. The other last word "din-ts" or quilt was currently used in the nursery to distinguish certain small crib pads from the regular bed quilts. Such mixed sentences containing only such words are of a very different type from E.'s

	AGE	J.	OLDER GIRLS	M. H. AND E.		YOUNGER BOYS	THREE ELDEST CHILDREN	FIVE YOUNGEST CHILDREN
	months							
Sentence length	18				H.	1.7		
	24	2.5	3.5	2.0	4.1	2.1	3.0	2.6
	30	4.5	4.0	3.6		2.5	4.2	3.0
	36	6.7	7.7	3.9	E.	5.6	7.4	5.3
	42	7.4	8.0	4.6	3.7	5.5	7.8	5.4
	48	9.0	9.7	7.5	6.6	6.4	9.4	6.8
	Av.	6.0	6.4	4.3		4.4	6.3	4.8
Errors per hundred words	18				H.	63		
	24	40	14	70	37	41	20	41
	30	12	18	31		65	15	46
	36	0	9	51	E.	8	7	15
	42	0	6	0	6	4	5	6
	48	0	1	3	0	1	0	1
	Av.	10	10	33		24	11	22
Inflected words per cent of Eng. nouns, verbs and modifiers	18				H.	2		
	24	0	0	12	5	11	0	8
	30	13	15	3		21	14	10
	36	17	19	18	E.	16	18	18
	42	19	22	23	31	16	21	15
	48	26	21	11	25	13	22	16
	Av.	15	15	13		15	15	13
Mixed sentences: Per cent of sentences containing both Chinese and English words	18				H.	28		
	24	0	0	0	10	26	0	18
	30	0	18	16		19	9	18
	36	0	6	7	E.	6	4	6
	42	0	1	0	0	0	1	0
	48	0	0	0	0	4	0	2
	Av.	0	5	5		11	5	9
Proportion of Chinese words recorded as spoken by the children	12	27	17	0	H.	68	53	73
	18	20		0	50	56	—	56
	24	0	0	16	2	76	0	47
	30	0	4	9		28	2	17
	36	0	2	2		2	1	2
	42	0	1	0	E.	0.4	1	0
	48	0	1*	0	0	0	0	0
	Av.	0	3	9		21	1	13
Average age at which confusion of the two languages ceased		Before 24	20	30	H. 22	33		
Average age of last recorded mixed sentence		None	39	38		40		

Averages do not include data below the age of 24 months.

* The Chinese words were proper nouns which could not be given in English.

sentence recorded as spoken at 35 months referring to the snow, (a rarity for him and for which he knew no word) "Jingming's bah sand makes my kyouh t'ung" which translated would read "God's white sand makes my feet hurt." The order is Chinese, the words about half English and half Chinese and the English inflection is attached to a Chinese noun. Is it any wonder that "Grandma does not understand much that E. says" when he visited her in America at 38 months although he was recorded as speaking better English and forgetting Chinese by 39 months old?

This superiority of the older children is not accompanied by any compensating superiority of Chinese on the part of the younger children for all the criteria but the one showing least difference take the Chinese as well as the English into consideration. We may therefore conclude that the confusion of source of languages does probably make learning to speak more difficult for a bilingual child than if the sources are reasonably distinct.

Considering next the effect of removal from a bilingual to a monolingual environment. J., the oldest boy and H. the youngest girl were both so removed at about 20 months old. Both of them had made considerable progress in speech by that time, the record stating that J. at 18 months was talking a good deal and that H. at 14 months was talking a good deal in Chinese and using short sentences at 19 months. She had begun to talk the earliest of all the children using six words at eight months and combining two words into her first sentence at nine months. Within two months after leaving China, she was beginning to pick up English and using less Chinese. In neither case was there a record of any mixed sentence after the children's second birthdays. At that date, H. was taken from her family for a two months visit to an aunt after which she no longer used any Chinese. J. however heard it occasionally in his family during the year of furlough and had no difficulty in recovering his Chinese upon return there. H.'s record at two years covering as it does all sentences used from 21 to 27 months covers this period of forgetting and her transition from bilingualism to monolingualism. Her record is given separately therefore as well as included in the record of the five youngest. Unfortunately after that period there is only a single sentence quoted. Dividing her two-year record into two parts by the date of her leaving for the visit to her aunt we find for the first interval a sentence length of 3.1, error index of 62, and a single use of inflection, that of the possessive sign; and for the latter period a sentence length of 5.0, error index of 20 and the same use of inflections. Her progress as she became adjusted to the monolingual environment was remarkable. These children do not show the difficulty that Mary and Avis Ann and a third infant reported to me (5) did when they underwent a similar move but they were younger and had not made the same start at learning to talk that J. and H. had.

The early speed of acquisition of words by the children, the fact that the average of the children's first use of words was ten months and in this respect the younger children were

ahead of the older (they first used a word at an average age of ten months and the oldest three at eleven months) suggest that the handicap of bilingualism is not felt at this stage but a little later and it is when the child is about eighteen months old that comments on slowness of further progress occur in the records of those who seem to be most handicapped.

M. was moved from China to America at a few weeks old and started learning to talk in America. At 13 months she used five English words. The next month the family returned to China and her exposure to bilingualism began. Her record shows relatively slow progress and the mother comments upon it. Finally at 19 months she remarks that M. has picked up a few Chinese words and at 21 months she begins to improve, "learning a new word almost every day." At two years she does not show any mixed sentences but a low per cent of such sentences is inevitable when the child is still using many one-word sentences as it is necessary that a sentence consists of at least two words before it can contain words from two languages. The transfer from a monolingual environment to a bilingual environment may be more confusing to an infant than the reverse and it is also noted that M. was younger than the two who made the reverse change.

E. is another child who had not mastered speech when the family moved to America. After the decision to leave China had been made, the mother states that she made a special effort to speak Chinese more than ever to the younger children. As a result (?) E. was the oldest of the children to continue his confusion of the two languages. He had been in America nearly three months before the record of his forgetting Chinese occurs. At 42 months nearly half a year after leaving China his sentences are 3.7 words in length, error index is 31 and use of inflections occurs in only 8 per cent of the words, the poorest record of all the children. Were it not for his previous low record and the slight disturbance caused the other two children moving to America at an earlier age and the additional fact that the younger of the two oldest girls who was only a little older than he during the furlough year in America shows no effect of the change, we might consider his slowness due to the change. It would appear more likely due in part, at least, to the same cause that affected the other younger boys, namely the confusion of source of English and Chinese. He had made considerable gain by four years as shown by the last quotations in his record. He made excellent progress when he started to school and his intelligence rating on the Army Alpha during the World War was A so his early slowness was not due to less intelligence than his siblings.

This analysis suggests that:

1. It is probably better for young bilingual children to receive their two languages from quite separate sources, each adult in the home using always the same language in speaking to them.

2. Change from a monolingual environment to a bilingual one affects a child's speech more than a change in the opposite direction.

3. Such changes are more difficult for an infant of twelve to eighteen

months than for those who have already made more progress in speech.

4. A bilingual environment does not seem to delay the first use of words, the handicap operating at a later age.

5. Although the numerical data cannot be compared with other studies of children's speech since the samples are probably selections of the children's best effort rather than of their average performance, yet the ratio of errors is in case of the younger children higher than the norms of two and three-year-olds found in a previous study, (6) (two years 36 and three years 15 per 100).

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Direction of Movements of Children in Emotional Responses

DOM GREGORY J. SCHRAMM

HISTORICAL INTRODUCTION

THIS experiment was devised to investigate to what extent, if any, the reactions classified as positive and negative reactions in studies of lower organisms may be important in the study of the emotional behavior of children; and to find what relation, if any, exists between spatial factors in the environment and the general reaction pattern of children under conditions that are generally considered emotion provoking. The problem may be briefly enunciated as follows: What is the direction of gross body movement of children to spatially controlled stimuli? Does this direction of movement indicate emotion?

The idea of spatial reaction as an index of emotional behavior has been slowly developed in child psychology. Watson (9) introduced the positive and negative terminology into experimental child studies. He has a paragraph caption "(0) Positive Reaction Tendencies." He writes, "Infants respond positively to nearly all small objects which are given a high stimulation value by moving them. No definite avoiding tendencies have been noted at this age, except those mentioned under blinking and defense reactions. . . . . Although we are not prepared to insist upon it we are inclined to believe that man is originally endowed with various kinds of positive reaction tendencies, but with few negative reaction tendencies."

Watson's eighth trial of "Albert" is described as follows: "The instant the rat was shown the baby began to cry. Almost instantly he turned sharply to the left, fell over, raised himself on all fours and began to crawl away so rapidly that he was caught with difficulty before he reached the edge of the table." Of this reaction Watson claims "This was as convincing a case of a completely conditioned fear response as could have been theoretically pictured." Generalizing on Watson's three emotions Tolman (8) states, "It must be observed that all response tendencies would apparently fall into one or the other, of the two classes of 'tending to remove' or of 'tending to continue and get more of' the stimulus. Anger and fear go into the first group and love in the second." But these classes translated into environmental terms are equivalent to reactions which decrease distance and make contact or increase distance.

Sherman (7) also detected this bipartile behavior reaction in infants and reduces all behavior of the newborn to the categories of the positive or negative reactions. He writes thus:

"The genesis of the specific emotional reactions of children and adults lies in the responses available to the newborn infant. The reactions are first generalized, but even in the earliest responses two types of reactions are noted: (1) that of rejecting the stimulus, and (2) that of accepting the stimulating condition."

Leslie Marston (6) makes positive and negative spatial movements of children a significant basis for measuring social resistance and compliance. Making a summary of results, he writes "In this experiment the children differed in degree of social resistance from the most extroverted, who showed no resistance but unhesitatingly approached the stranger and uninvited played with the toy (score 5) to the most introverted whose social resistance withstood the stranger's advances and rejected his inducements (score 0)."

Spatial specifications and relations have been used by Levy and Tulchin (5) in the description of resistance behavior of 983 children tested at a county fair and of 110 others tested under controlled conditions in the laboratory. In the first study they conclude: "The manifestation of resistance by infants and children during mental testing is evidence of some innate behavior pattern." In the second study the authors analyzed the resistance behavior into 8 pattern groups, the sixth of which contains the following: "Several withdrawal movements with or without taking the object; walking back to mother; turning head and burrowing in mother's clothes; turning head away toward mother, holding head downward, covering face with hands, looking away."

The presence or absence of a positive spatial reaction is the criterion of scoring most items of Gesell's (1) maturity chart for one-year-olds. These items which he considers symptoms of developmental levels, are all, except one concerning speech, reducible to spatial movements of the infant in response to a stimulus object. The same criterion of scoring maturity is found in his scale for pre-school children (2).

M. C. Jones (4) while eliminating fears from children found that the "direct conditioning" was the best method of elimination. It should be noted that in this process the spatial relation of the animal was at every stage of the process the measure of the emotional equilibrium of the children being unconditioned.

According to a study of H. E. and M. C. Jones (3) jumping frogs, jack-in-the-box, and upsnapping beetles most frequently elicit fear reactions in children, while worms and catepillars produce no more than mild curiosity. The difference in these groups of stimuli lies in the sudden and extended locomotion or spatial changes of the former compared to the latter.

In an experiment with six young children, thirty-six older children ranging from six to 10 years and 90 collegiate adults in the presence of a harmless snake 6 feet long and 4 inches in girth, these authors describe the reactions largely in spatial terms. Some of the terms are the following: "reached and grasped," "held his ground," "started to leave," "took up a post of observation outside of pen,"

"drew away," "moved forward," "crowding close," "climbed on table," "refused to come near," "ran around behind the circle," "nearly one third refused to have the snake brought near," "the remainder reached forward." Broadly the whole array of subjects in an emotional situation are divided into those who permitted the object to be near or reacted positively and those who acted in a contrary manner.

Apparently positive and negative reactions are characteristic of the behavior of children in responding to stimuli that provoke emotion. The aim of this study is the experimental determination of the positive and negative reactions of children under conditions that vary the spatial factors in the relation of the child to the stimulus.

PROCEDURE

It was desired to present two situations, one in which the subject was placed free in a spatial relation to a stationary stimulus object and the other where the child was relatively stationary while the stimulus was moved toward or away from him.

For this reason two tests were devised. The one called the Sitting test, in which the child was fixed in a chair and animals as stimuli-objects, were moved toward and away from the child. The second test was the Standing test, in which the controlled conditions permitted the child to stand freely in space in the presence of animal-stimuli which were relatively fixed, on a table.

Thus both tests reveal body movement of the child in space. The sitting test provides observation of small spatial trunk swaying of the child in the chair, under controlled conditions. The standing test gives a record of the gross spatial movements of the walking child with the stimulus object restricted.

The reactors were children from the Child Institute of the Johns Hopkins University. There were 22 reactors, 15 were boys and 7 were girls. Their ages ranged from thirty-six to sixty-four months. Twenty of these participated in the standing test. The Intelligence Quotient of each was above 1.00. A few refused to submit to the chair situation; a few entered after the completion of the standing test. As a rule the child freely said "Take me" and tended to run ahead of Experimenter into the experiment room but in the cases of A and R it was necessary to coax. N could not be induced to walk through the corridor to the observation room unless accompanied by an institute assistant.

Apparatus for sitting test

The sitting test involved a relatively fixed subject and a moving, *i.e.*, approaching or receding stimulus animal. Actually the child could move several inches each way in the chair. The stimuli were moved through a distance of 24 inches, in three or six inch intervals, toward or away from the child. The movements of child and of stimulus were mechanically recorded.

The apparatus for the sitting test is illustrated in figure 1. It consisted of a chair with a back, two arm rests and a front tray, something like a baby high chair. The rigid parts of the chair in contact with the body, that is, the back, the sides and the

front were equipped with an air cushion for each. These 4 air cushions made of inner tube sections were connected by separate tubings with 4 individual pressure bulbs and recording tambours; thus forming 4 closed pneumatic systems. Any body movement of the sitting child in a ventral, dorsal or lateral direction was transmitted to the respective tambour and there recorded on a kymogram.

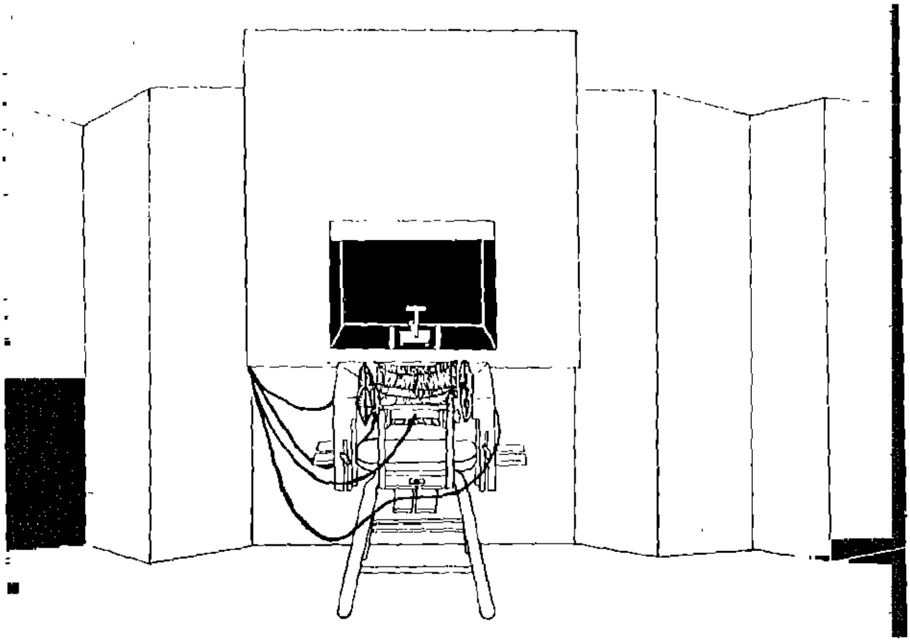

FIG. 1. APPARATUS FOR SITTING TEST

The exposure apparatus or stimulus-stage consisted of a small stage having a cubic extension of 2 feet, built upon a table. The front of the stage was equipped with a screen which could be raised or lowered at will by the Experimenter to expose the stimulus object. A metallic point on this screen automatically recorded on the kymogram the opening and closing of the drop-curtain and the exposure of the stimulus at the initial position.

In the back of the stage an opening equipped with 2 points of an electric circuit was made at the center at the floor level. Fitting into this opening and moving through it was a one inch wooden rod equipped with circling bands of zinc, at every three inches to record the movement of the rod. When the tray bearing the animal stimulus was moved forward or backward by means of the rod projecting through the rear stage wall, the metallic rings closed the electric circuit and the position of the stimulus tray was kymographically recorded. A scale in inches was marked on the rod carrying the stimulus which was moved

forward or backward on the stage by the Experimenter standing behind the screen. A stop watch was used to make the intervals between stimulation at given distances uniformly 30 seconds. The exact time interval was mechanically recorded on the kymogram. The illustration shows the animal tray equipped with a small perch for the paroquet experiment. The other animals were bound to the tray.

In the ceiling of this small stage a mild electric bulb was placed which shone down upon the stimulus object and afforded uniform illumination at all times.

The recording apparatus consisted of a kymograph and 6 markers, 4 of which were pneumatic and 2 magnetic. The 4 pneumatic markers were tambours, one each for the 4 air-pressure cushions acted upon by the movements of the child in the chair. On the kymogram the top or L line shows the record of the left side movements or compression by the moving child, the R line represents the right lateral movements, the V line the ventral pressures, and the D or fourth line the dorsal compressions.

The 2 magnetic markers were activated as follows: The fifth marker or time line was operated from a continuously running electric clock in an adjoining room; the bottom marker recorded the raising and lowering of the exposure screen and the positions of the stimulus rod and animal.

Stimuli objects. The stimuli objects were animals. The introductory stimulus was a ten inch glass bowl containing 2 gold-fish, each 2 inches in length. This was used on the regular exposure stage with the air-cushions under compression.

The other stimuli were, a small green frog, 2 ounces in weight; a large market frog, 11 ounces in weight; a white rat, body 6 inches long; a gray rabbit, 4 pounds in weight; and a green paroquet 6 inches long.

These animals were attached to the stimulus-rod and moved toward or away from the child sitting in the chair. The frogs were fastened to the tray by means of strings tied to their legs and hands, which made hopping impossible. The rat and rabbit were held in place by a wire passed around their neck and fastened to a ring between their fore legs. These bands were quite invisible, and were not once remarked upon by the child-subjects. The paroquet was trained to sit on a perch while being exposed. However it was prevented from flying away by a fine eye-glass chain which was passed around its leg and attached to the perch. The chain was quite visible. Except for the frogs which slowly writhed on their tray the stimuli animals were quiet, and never moved off their tray during exposure.

Procedure of the sitting test. In the beginning the Experimenter addressed a group of children as follows: "I want to show you something next door. I will be able to take only one at a time. It is now ——'s turn." Later the appointments were made through the Institute assistants in order to avoid disturbance of group activities. The same arrangement applied when the subjects were taken from the playground.

On arrival at the test room, the

subject was asked to take off outdoor top-clothes if he had them on, was engaged in a casual conversation about the room and permitted to play for a minute with a new toy; then asked to sit in the chair. He was told "In a few minutes I will show you something in that window."

The child was permitted, even encouraged to get in the chair by himself. In case of climbing inability the Experimenter assisted him into chair, then said: "Won't you let me move the arms of the chair closer to you so they fit snugly?" and thereupon adjusted cushions. Next, "Let me put this arm-rest (tray) under your arms to make you comfortable. This fits like a baby chair, doesn't it? Do you have one at home? etc." Experimenter left subject a minute and adjusted the pressure of the 4 air systems each of which had an individual bulb. Coming back to the child, he said: "Let me move you nearer the window, so you can see the things I want to show you. Lay your hands on the tray like this." The chair was shifted in a position directly in front of the screen, as shown in the diagram of apparatus. Experimenter placed the hands palms down on the tray in a relaxed position, then said, "Now I'll go and open the window for you to see what is there."

When tambours were balanced, the child was asked, "Are you ready?" and the kymograph was started. After counting five, the curtain was raised exposing the animal at the initial 24 inch distance, stop watch was started, and the behavior of subject was recorded in writing.

The stimulus object was permitted to rest in a given position approximately 30 seconds and then pushed forward, not jerked, 3 inches during the space of 1 second to the next position. Such forward movements were made until the stimulus object reached the edge of the stage, or as far as the child would tolerate it. Then the stimulus object was drawn back 3 inches as every 30 seconds elapsed until the initial position was regained which was also maintained for 30 seconds, following which the curtain was dropped. At the end of the series when the drop curtain was lowered the child was immediately released by unlatching the tray of the chair. The child was then engaged in some irrelevant conversation, permitted to play with a toy for a few minutes, helped to put on his top clothes and escorted back to the playground or work-room.

The following modifications of procedure were introduced. The experimenter spoke to the child when crying seemed imminent and asked "What is it?" Usually no answer was given to direct questions as "Will he bite, jump, or fly?" In case of the child protesting and wanting "to go and get out," he was put off repeatedly by saying, "Just a minute longer." In a few cases of continuous protest, extreme agitation and loud crying the series of approaching positions was shortened and even the curtain dropped. However, the necessity of rapport, future coöperation and the welfare of the children required such individual variations of the procedure. It is our opinion that the active factors in the situation operated in spite of the shortening of exposure and approach series, by reason of a lowered reaction

threshold, in the very few cases where this occurred.

Results of sitting test. The data of this sitting test were treated by application of the fifth experimental method of John Stuart Mills. Mills' formulation of the law of the "Method of concomitant variations" is as follows: "Whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner, is either a cause or an effect of that phenomenon or is connected with it by some fact of causation." Simultaneous variation of position of the subjects as recorded by the tambours with that of the animal stimuli as recorded by the electro-magnets are assumed to show a causal dependence of the behavior of the children upon the spatial movement of the stimuli.

After a shellac bath, the kymographic records were read by means of a transparent triangle engraved in centimeter units. In this reading the time line or stimulus line was used as the base line. Readings of the height of the pressure line were taken for each second or each two second periods. The readings for the interval from one distance of stimulus to the next were averaged for that period. These averages were considered an expression of the directional activity for the given distance. Thus in the case of Q reacting to the rabbit as shown in figure 2, III we have

Stage, In...	24	21	18	15	12	15	18	21	24
Left, cm...	13.5	13.3	12.8	13.3	13.0	12.6	12.9	12.5	13.0
Right, cm..	11.1	11.5	11.3	11.7	11.6	11.8	10.8	10.0	99.9
Ventral, cm.	8.1	8.3	8.1	8.7	8.5	7.8	7.2	6.8	6.5
Dorsal, cm.	2.5	2.3	2.5	2.1	2.2	2.5	2.7	3.2	4.2

Ventral and dorsal concomitance. By concomitance is meant that as the stimulus moves successively in a forward or backward direction the subject reacts in a consistent direction that is somewhat proportionate to the movement of the stimulus by moving forward or backward or vice versa. This does not mean that such consistency existed throughout the exposure series in every case but it does mean that there was a proportionate variation in the subject's behavior in four or five successive stages. Nor does this mean that dorsal variation must always compensate or balance ventral variation and vice versa. This is due to the fact that the dorsal and the ventral contours of the body are not symmetrical, like the lateral contours. Hence concomitance is read from either dorsal or ventral data, not necessarily from both. In case of a longer series of concomitant variations one stage or measure out of proportion was not considered to destroy the concomitance.

The inches refer to the position or distance of stimulus from the child. The centimeters refer to the height of the tambour record above the base line of the kymogram. The letters L., R., V., D., mean left, right, ventral and dorsal compressions, respectively.

In the record of Q and rabbit shown in figure 2, III we note concomitant increase in the ventral pressure and a concomitant decrease in dorsal pressure as the stimulus object approaches the subject. This is a case of positive concomitant variation.

Positive variation, *i.e.*, increased ventral pressure with the approach of the stimulus can also be noted in figure 2, IV of H's reaction to the rabbit. Increased dorsal pressure is

apparent in figure 3, representing reactions of C to large frog and of D to the rabbit.

The scoring of a concomitant variation does not signify there may not have been more than one series of successive variations in a given test for a give individual. In case there were more than one, only one was recorded and scored. Thus a child may have been concomitantly positive up to the mid point of the series and then suddenly become negative and relaxed as the stimulus receded or may have maintained a negative summation attitude The scoring for "none," for the absence of concomitant variation does not signify anything as to the positive or negative orientation of the reaction. It only signifies that there was no proportionate dorsal or ventral movements although there may have been such an abundance of movement as to make subsequent analysis impossible.

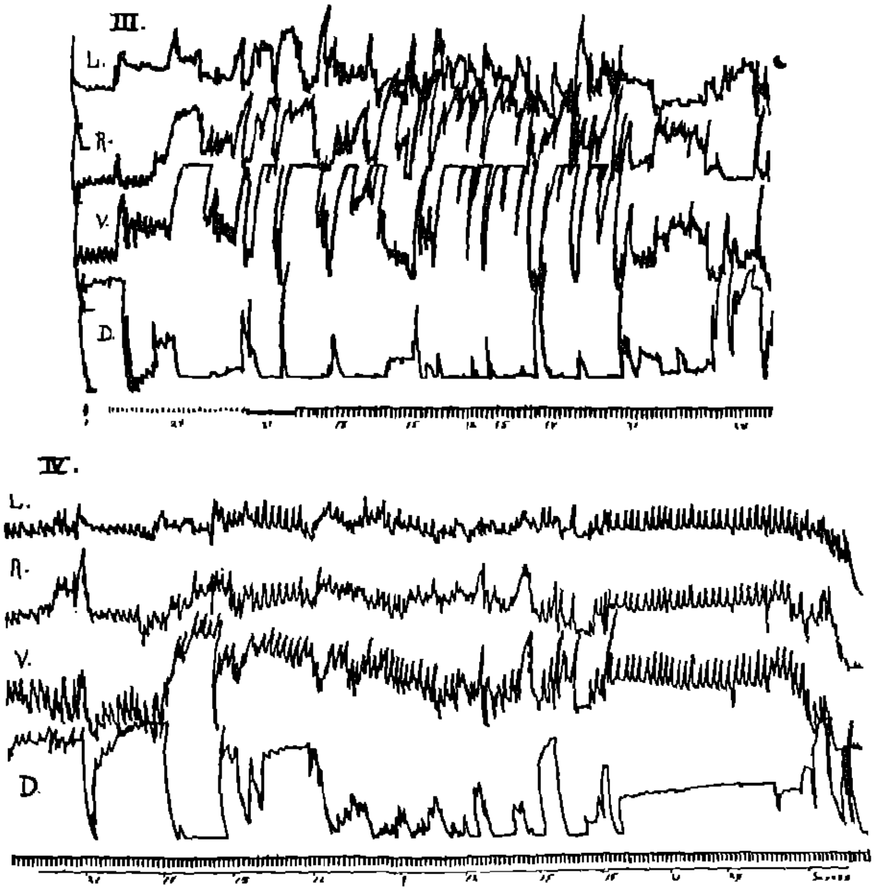

FIG. 2. POSITIVE CONCOMITANT VARIATION IN REACTIONS TO RABBIT. III, *Q*. IV, *H*

In obtaining these measures it has

at times been necessary to discount the first reading which occurred with the raising of the drop-curtain. The upward movement of this curtain usually causes a dorsal compression due to the eye and head raising t fixate the moving curtain, this in tur adds weight to the backward balance of the body. Furthermore some children are inclined to try to peep as the

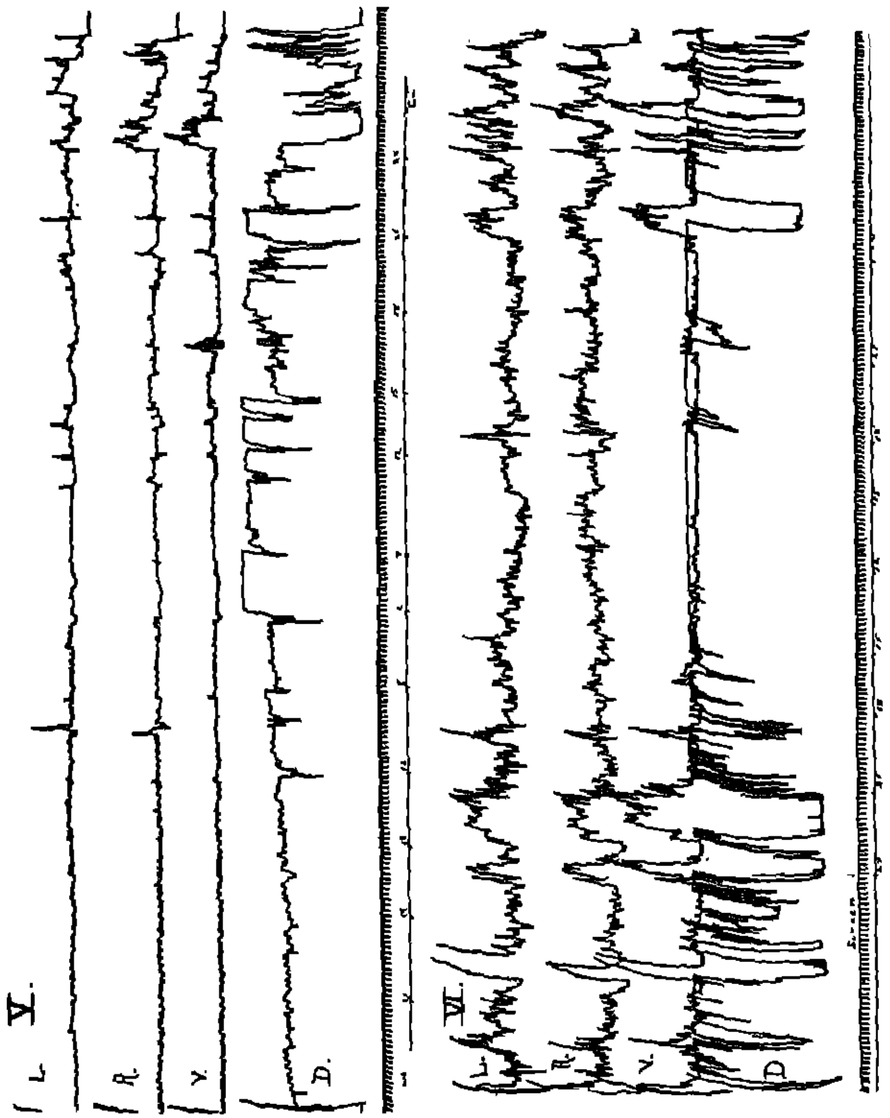

FIG. 8. NEGATIVE CONCOMITANT VARIATION. V. C TO LARGE FROG. VI. D TO RABBIT

curtain starts to move. This would occasion a dorsal pressure due to lowering the head.

Later concomitant variation. Lateral concomitant variation of reaction is taken to be successively increasing or decreasing pressure on the left side with a decreasing or increasing pressure on the right side in proportion to the movements of the stimulus object or vice versa. Since the lateral sides of the body are symmetrical negative movements on one side ought to be accompanied by positive movements on the other side. Simultaneous positive or negative variation on both sides is an artifact due to friction of the body moving in a ventral or dorsal direction and hence can not be scored as lateral movements. Such recorded bilateral scores neutralize themselves in so far as they destroy concomitance.

A trifling source of error more frequent on the ventral side than on the lateral sides was the manipulation or finger pinching of the edges of the air cushions. Finger manipulation did not occur frequently and unless all the fingers were simultaneously involved did not introduce a notable compression variation.

Much of the lateral compression was caused by arm movements of the children while reaching for the stimuli. The arm extension and its projection tended to draw the shoulder in the same direction and similarly to move the given side of the body forward. This likewise caused a frictional pressure on the lateral cushions although the body did not move to the right or left. Obviously most of the lateral movement as recorded was of a non-concomitant frequency.

Positive and negative reactions. Table 1 gives the reaction of children to approaching or receding stimuli. Obviously the fact of the presence of concomitant variation does not tell us whether it occurred in relation to the coming or the going stimulus and whether it was positive or negative. For this reason the reactions of the children were analyzed and divided on the basis of the coming and going movements of the stimuli. Movements as noted on this table do not imply that they were all concomitant but that the general trend was of an approaching, pursuing, retreating, or withdrawing pattern on the part of the subject for a certain part of the series. Many of them were of the concomitant variation type. In this table concomitant variations which reached across the central point of the series are split as is demanded by the double basis of analysis reading from 24 inches to 0 inches and on the other hand from 0 inches to 24 inches. Thus in the case of Q with the rabbit, his behavior is analyzed as approaching the coming stimulus and pursuing it when receded, hence the reaction is concomitant and positive to the movement of the stimulus throughout. This is illustrated in figure 2 and records a case of retreat to the approaching object and withdrawals from the retreating object. Figure 4,I records a negative reaction to a stationary stimulus. Figure 4,II records a highly negative reaction which lasted as long as the stimulus was exposed. One may note sharp rise of dorsal pointer after exposure and sharp drop after screen closure.

The high percentage of concomitant variation in the total of the tests shows

that there is a definite causality between the successive spatial positions of the stimuli and the reaction behavior. Not only does the stimulus cause a reaction but proportionate proximity and proportionate distance of the same stimulus causes a propor-

recording reactions of M to the white rat.

The small proportion of the concomitant lateral movements as shown in table 2 in relation to the moving stimulus shows that the stimulus did not cause lateral movements, that is,

TABLE 1

Cases of forward and backward movement
or
Ventral or dorsal concomitant variation of children with successively varying stimulus
c.v., concomitant variation; *none*, absence of concomitant variation

CHILD	SMALL FROG	WHITE RAT	LARGE FROG	RABBIT	PAROQUET	C.V.	NONE
A	−c.v.	−c.v.		−c.v.	−c.v.	4	
B	−c.v.	c.v.	none	c.v.	−c.v.s.	4	1
C	none	none	−c.v.	−c.v.	−c.v.	3	2
D	none	−c.v.	−c.v.	−c.v.	none	3	2
G		−c.v.	−c.v.	−c.v.	−c.v.	4	
H	−c.v.	none	none	c.v.	c.v.	3	2
J		none	−c.v.	−c.v.s.	−c.v.s.	3	1
K	−c.v.	c.v.	−c.v.	−c.v.s.	none	4	1
L	−c.v.			none	c.v.	1	2
M	−c.v.	none	c.v.	c.v.	c.v.	4	1
N	none	−c.v.	none	−c.v.s.	none	3	2
O	c.v.	c.v.	c.v.	−c.v.	−c.v.	5	
P	c.v.	c.v.	c.v.	−c.v.	−c.v.s.	5	
Q	−c.v.	−c.v.	−c.v.	c.v.	−c.v.	5	
R	none	−c.v.	−c.v.	−c.v.s.	none	3	2
S	−c.v.	−c.v.s.	−c.v.s.	−c.v.	−c.v.	5	
T	none	−c.v.	−c.v.	−c.v.	−c.v.	4	1
U	none	c.v.	none	−c.v.	c.v.	3	2
V	−c.v.	−c.v.	−c.v.	−c.v.	c.v.	5	
Total:							
c.v.......	11	14	13	18	15	71	
none......	6	4	4	1	4		19

c.v., 79 per cent; none, 21 per cent.

tionate or concomitantly varying behavior. Factors of space are active principles in the behavior of children in their emotional behavior. A case of the absence of any concomitant variation of the dorsal and ventral aspects may be seen in figure 5, VII

lateral movements are not an important factor in reacting to approaching stimuli.

In table 3 the ventral and dorsal pressure variations are shown for the individuals in the group when the large frog was the animal that was approach-

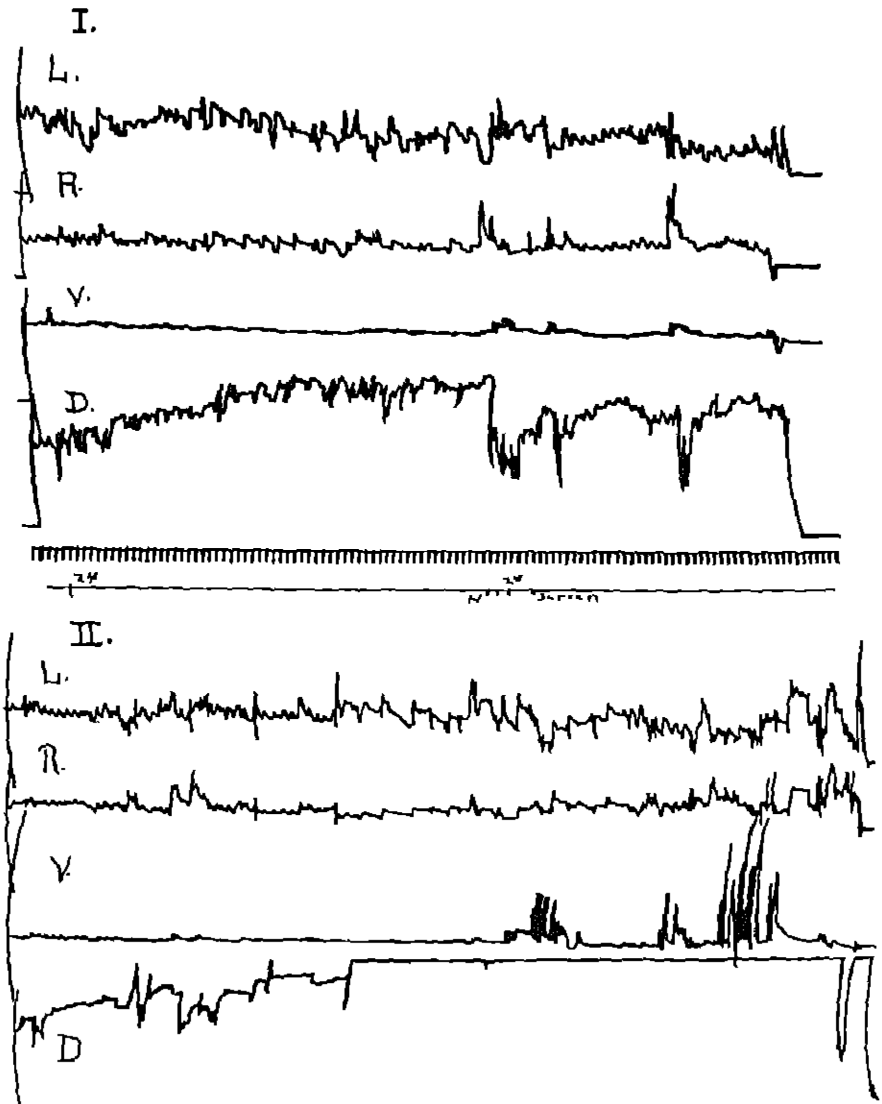

FIG. 4. NEGATIVE VARIATION AND SUMMATION. *I. R* TO STATIONARY RABBIT. II. *A* TO MOVING PAROQUET

ing or receding from the child in the chair. The highest point of the pressure line within a two second interval as recorded on the drum was read and

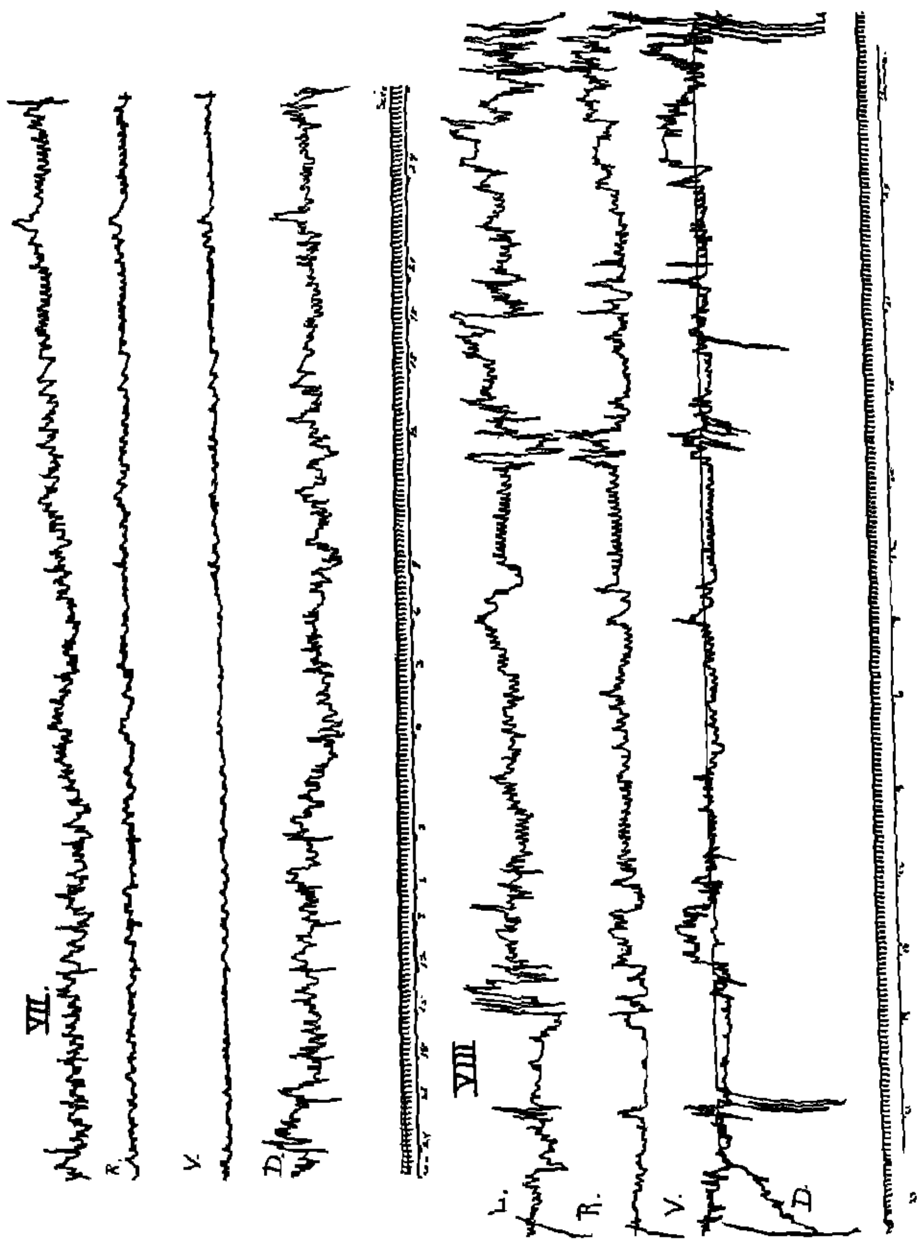

FIG. 5. NO CONCOMITANT VARIATION AND CONTINUOUS NEGATIVE REACTIONS. VII. *M* TO WHITE RAT. VIII. *H* TO LARGE FROG

listed. The average of these readings for the period from the presentation of the animal at a given distance from the child to the next presentation

at another distance was calculated. These mean scores are shown for varying distances. In figure 6 the group curves and those for individual C illustrate the variations in pressure to the approaching and receding frog.

Reactions to different animals. In table 4, the data show that the small frog elicited the least number of positive reactions, the second largest number of negative reactions and by far the largest number of doubtful reactions. This was the first item in the series and strangeness or novelty of the apparatus may have been operative. Comparing the reactions to the small frog with those to the large frog one notes the increasing number of positive reactions to the larger frog. The larger frog also happened to be later in the series. During the interval between the testing with the small and the large frog a month had elapsed during which all but G and J had had opportunity to react to two small frogs in the play room for a few days. In the case of the large frog, doubtful reactions are greatly reduced to one third of the number to little frog.

TABLE 2

Lateral concomitant variation of children with successively varying stimulus

c.v., concomitant variation; *none*, absence of concomitant variation

CHILD	SMALL FROG	WHITE RAT	LARGE FROG	RABBIT	PAROQUET	T C.V.	T NONE
A	none	none		none	none		4
B	none	none	none	none	none	1	5
C	none	none	none	c.v.	none		4
D	none	none	none	none	none		5
G		none	none	none	none		4
H	none	none	none	none	none		5
J		none	none	none	none		4
K	none	none	none	none	none		5
L	none			none	none		3
M	none	none	none	none	none		5
N	none	none	none	none	none		5
O	none	none	none	none	none		5
P	none	none	none	none	none		5
Q	none	none	none	none	none		5
R	none	none	none	none	none		5
S	none	none	none	none	none		5
T	none	none	none	none	none		5
U	none	none	none	none	none		5
V	none	none	none	c.v.	none	1	4
Total:							
c.v.	0	0	0	2	0	2	
none	17	18	17	17	19		88

c.v., 2.2 per cent; none, 97.7 per cent.

The white rat is the only animal which elicited more positive reactions than negative ones. This is probably

TABLE 3

Pressure variations to large frog

REACTORS	STIMULUS APPROACHING							STIMULUS RECEDING					
	Distance in inches												
	24	21	18	15	12	9	6	9	12	15	18	21	24
Ventral													
A	09	03	63										
B	68	05	65	62	62	60	57	62	01	66	65	63	65
C	69	09	70	70	70	64	69	70	70	70	69	71	74
D	74	73	08	68	68	67							
G	05	65	62	62	62	62			66	12	62	65	65
H	62	66	59	68	02	59	01	60	60	65	61	61	67
J	630	500	642	000	570	500			057	599	590	735	032
K	7	7	7	7	7	7	7	7	7	7	7	7	7
L													
M	74	71	72	75	71	73	75	72	75	75	75	74	72
N	70	71	70	68	72	80			73	70	65	65	06
O	71	80	70	79	75	84	92	72	82	81	78	89	
P	05	65	72	68	00					69	65	60	77
Q	0	82		07	03	03	50	59	60	00	63	66	57
R	04	02	62	02							66	06	03
S	07	67	68	08	07	67			67	67	67	07	07
T	07	60	07	08	68					61	68	65	65
U	55	60	69	82	03	56	54	68	68	60	50	60	62
V	57	54	56	54	51	50			53	52	54	53	54
Total..........	1576	1682	1641	1628	1500	1381	474	400	1300	1414	1506	1663	1547
Arithmetic mean.........	84.2	93.4	96.5	95.8	93.8	98.6	59.3	51.5	107.6	94.3	94.1	103.9	103.1
Dorsal													
A	50	54	00										
B	50	51	52	57	57	58	68	54	54	57	57	57	53
C	46	44	45	47	47	49	60	55	51	48	46	44	29
D	40	40	65	68	64	62							
G	56	03	65	65	65	66			65	60	05	53	54
H	64	02	01	01	63	03	63	63	63	62	62	63	63
J	437	550	560	600	580	587			567	522	522	475	405
K	8	42	5	52	51	52	55	55	53	55	56	57	58
L													
M	37	34	33	31	31	31	28	28	32	32	34	36	36
N	45	37	43	50	37	30			60	57	60	60	60
O	43	35	37	43	41	42	34	49	31	39	47	32	
P	47	50	40	40	33					39	40	34	27
Q	34	32		38	43	48	58	51	53	59	44	32	48
R	37	49	52	55							54	46	42
S	53	45	40	51	50	53			53	45	53	54	57
T	47	54	50	57	59					50	45	55	50
U	39	43	40	13	23	33	23	43	13	13	36	48	53
V	51	54	54	52	56	50			50	55	50	50	53
Total...........	1170	1345	1314	1380	1312	1234	370	308	1141	1103	1277	1201	1154
Arithmetic mean.......	65.0	74.7	77.3	81.1	82.0	88.1	47.4	49.8	87.8	70.5	70.8	75.1	70.0

due to the fact that several of the children had a caged rat in the institute playground the year before. B, K, and C were among the group and reacted positively; but R who had the same experience still reacted negatively.

The rabbit elicited the largest number of positive reactions or 47 per cent of the total. It also occasioned the least number of doubtful reactions or 5 per cent. Reactions to this stimulus which was the largest stimulus were the most clear cut but practically equally divided as to positiveness and negativeness.

The paroquet occasioned more negative reactions than positive responses. It also elicited a high percentage of doubtful responses. The paroquet was rather nervous on his perch and used his hooked beak continuously in eating grain or at biting the chain.

An analysis of the total approach, retreat, pursuit, and withdrawal reactions shows that 36 per cent of 182 responses were positive, 43 per cent were negative and 20 per cent were doubtful. Approach was the reaction of least frequency. This might be expected since it would require a rapid decrease of distance between the already approaching objects.

But the withdrawal from the reced-

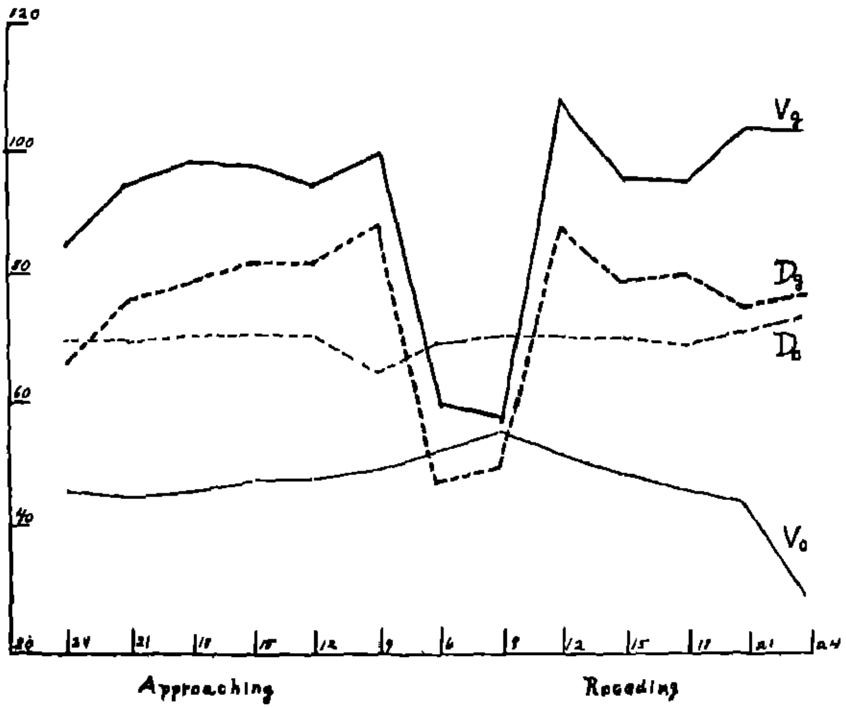

FIG. 6. VENTRAL AND DORSAL PRESSURE VARIATIONS AT DIFFERENT DISTANCES

V_g and D_g are group curves based on averages of group scores for each interval. V_c and D_c are curves for individual C.

ing stimulus was only of secondary frequency, *i.e.*, 16 per cent of the cases. This was to be expected since the children probably inferred the crisis was lack of emotional shift from the previous retreat.

The retreat pattern from the approaching stimulus totals 49 or 27

TABLE 4

Reaction of child to approaching or receding stimulus

Ap.—Approach; *Rt.*—Retreat; *Ps.*—Pursuit; *Wd.*—Withdrawal; *Wds.*—Withdrawal summation

— no test given. ... Doubtful responses

	SMALL FROG		WHITE RAT		LARGE FROG		RABBIT		PAROQUET	
	Coming	Going	Coming	Going	Coming	Going	Coming	Going	Coming	Going
A	Rt.	...	Rt.	Ps.	Rt.	...	Ap.	Ps.	Rt.	Wds.
B	...	Wds.	Ap.	Ps.	Rt.	Wds.	Ap.	Ps.	Rt.	Wds.
C	...	...	...	Wd.	Rt.	Ps.	Rt.	Ps.	Rt.	Wds.
D	...	...	Rt.	Ps.	Rt.	...	Rt.	Ps.	Rt.	...
G	—	—	Rt.	Wds.	Rt.	Ps.	Rt.	Ps.	Rt.	Wds.
H	Rt.	Ps.	...	...	...	Wd.	Ap.	Ps.	...	...
J	—	—	...	...	Rt.	Ps.	Rt.	Wds.	Rt.	Wds.
K	Rt.	Wds.	Ap.	Wds.	Rt.	Wds.	Rt.	Wds.	Ap.	Wds.
L	Rt.	...	—	—	—	—	...	...	...	...
M	Rt.	...	...	...	Ap.	Ps.	Ap.	Ps.	Ap.	Ps.
N	...	...	Rt.	Ps.	...	...	Rt.	Wds.	Ap.	Wd.
O	Ap.	Ps.	Ap.	Ps.	Ap.	Wd.	Rt.	Ps.	Ap.	Wd.
P	Ap.	Wd.	Ap.	Wd.	Ap.	Ps.	Rt.	Ps.	...	Ps.
Q	Rt.	Wds.	Ap.	Ps.	Rt.	Ps.	Ap.	Ps.	Ap.	Ps.
R	...	...	Rt.	Ps.	Rt.	Ps.	Rt.	Wds.	Rt.	Ps.
S	Rt.	Wds.	Rt.	Wds.	Rt.	Ps.	Rt.	Ps.	Rt.	Ps.
T	...	...	Rt.	Wds.	Rt.	Ps.	Rt.	Ps.	Rt.	Wds.
U	...	...	Ap.	Ps.	Ap.	Ps.	Rt.	Wds.	Ap.	Ps.
V	Rt.	Ps.	Rt.	Ps.	Rt.	Wds.	Ap.	Wd.	Ap.	Ps.
Totals of types of reactions:										
Approach	2	0	6	0	4	0	6	0	6	0
Retreat	8	0	8	0	12	0	12	0	9	0
Pursuit	0	3	0	9	0	10	0	12	0	8
Withdrawal	0	1	0	2	0	2	0	1	0	1
Withdrawal summation	0	4	0	4	0	3	0	5	0	7
Doubtful	7	9	4	3	2	3	1	1	3	3

over. This reaction in most cases is due to summation of a negative reaction or fatigue which keeps the child resting in a relaxed condition on the dorsal cushion. It may also show a per cent of all cases. It occurred twice as often as approach in every case except with the paroquet.

The remarkable fact is that "pursuit" had such a great frequency while

its positive counterpart in this test, "approach" had the smallest. For this group when a stimulus is going away, pursuit is the mode of reacting to it, although retreat may have been the previous reaction-pattern.

TABLE 5
Individual reactions

	COMING ANIMAL		GOING ANIMAL		DOUBTFUL
	Approach	Retreat	Pursuit	Withdrawal	
Older children					
A	1	4	2	1	2
B	1	2	2	2	2
C		3	2	2	3
D		3	2		5
E		4	2	2	
H	2	1	2	2	3
J	1	2	2	1	2
K	1	3	1	4	1
L		1		1	5
M	3	1	2	1	3
N		2	2	1	5
Total........	10	26	19	10	31
Younger					
O	4	1	4	1	
P	3	2	3	2	
Q		4	3	4	1
R		4	2	2	2
S		5	2	3	
T		4	2	2	2
U	3	1	3	1	2
V	2	3	3	1	2
Total........	14	23	23	14	6
Grand total..	24	49	42	30	37

Table 5 shows that the younger group excelled the older in definitive reaction patterns. The younger children tend to make clear cut reactions.

Besides the concomitant variation of body position in regard to stimulus movements which shows the stimulus movement is a real causal factor in emotional behavior we have the corroborative testimony of the verbal report of the children. No formal questions were asked and speech was not encouraged, yet 120 verbal reports expressing the idea of distance were recorded. Some children made no verbal expressions, others made several in one test. However such that were made indicated consciousness of space factors. Usually when the object was far away the word was "Move it over to me," "Move it out," Then "have more," "a tiny bit more," "Push it some more." As the object moved closer the expressions were "That's enough" or "Enough," "Please don't," "I don't want it near." "Push it back," "Pull it away," all of which shows an explicit awareness of the space factor in the emotional situation. Some children protested "That's enough" at the 21 inch distance, others did not do so until the stimulus approached to within a few inches.

Head and hand movements. In cases where positive body movements were recorded the head was usually moved forward and the hands rested in front of the body on the tray of the chair or on the floor of the stage or were in contact with the stimulus object usually with intermittent withdrawals.

But where dorsal compression and negative report occurred the head was drawn back and the hands were fisted and held on the chest, or flat back on the shoulders or even back and hanging down behind the arm rests. In about an equal number of cases, the

fingers of one or both hands were put in the mouth, while a few pulled on their ears and hair. This last behavior was especially true of R and S.

Summary of results. Analysis of the data show that concomitant variations in ventral and dorsal pressure or consistency in responses toward approaching or receding stimuli are found in 79 per cent of the cases. Lateral concomitance is found in only 2.2 per cent of the cases. The movements to either side appear to be of little importance in response to stimuli moving forward and backward before a child restricted in a chair.

Concomitant variation or consistency in response does not show the types of response. In some cases there was withdrawal from both approaching and receding stimuli; in others withdrawal from the approaching and pursuit of the receding animal. The distance of the animal from the child was also a factor as some children consistently approached an animal coming toward them up to a certain point and then withdrew; in other cases the child failed to begin pursuit of a receding animal until he was at a distance from him. The most frequent reactions were withdrawal from the approaching animal and pursuit of the receding animal.

Reactions varied to different animals. Familiarity with the animal appears to be influential and also size of the animal. The white rat and the rabbit with which some children were familiar elicited a greater number of approach responses to the coming animal than did the other stimuli. These larger animals also elicited a greater number of retreats.

As the series progressed avertive behavior was less violent and approach reactions were freer. This would indicate reduction of emotion with successive presentations. Verbal reports tend to corroborate the findings from pressure variations.

It is already shown that not only movement of stimuli but the direction of movement relative to the position of the child is a factor of importance in the emotional behavior of the child. The number and types of movements of the child in relation to the movements of the stimulus object appear to indicate the degree of emotion aroused in the child.

MATERIALS AND STIMULI FOR STANDING TEST

In this test the major objective was the freedom of the child in approach toward or retreat from animals. An oil cloth rug 8 feet square having 4 concentric circles 1 foot apart or varying in diameter by 2 feet was placed upon the floor. A small table about 18 inches square and 18 inches high was placed in the center of the inmost circle and the stimulus object fixed upon the table as illustrated in figure 7. The stimulus objects were 3 young chicks less than three weeks old, 3 large frogs weighing two thirds of a pound each, 1 rabbit weighing about 4 pounds. These objects were placed upon the table, one kind of animal at a time, covered by a cloth of one of three bright colors. The chicks and frogs were contained in a glass dish three inches high and surrounded with a wire cage 8 inches high but open at the top. Quarter inch mesh afforded clear visibility of the object which was

illuminated from above when the cloth was removed. In the case of the rabbit a wire cage was inverted over him and the cloth draped upon the cage. On exposure of the rabbit the cloth and cage were lifted off.

Procedure in standing test

The children were brought into the room singly, where one draped object was already on the table. The experimenter stood by the child at the circumference of the outermost circle, and facing the table, gave the following direction: "This is a game. It is your part of the game to stand on this line at the start, but you can walk about as soon as I say 'Go.' I am going to show you something, which is on the table under the cloth, but you are to stand still, until I pull the cloth off the thing that is on the table. Then you can walk about and do anything you please to it." Moving to the table, stop-watch in one hand, he asks, "Now are you ready?" When the subject says "yes," the cloth is drawn off the object and placed upon a table about five feet from the stimulus object.

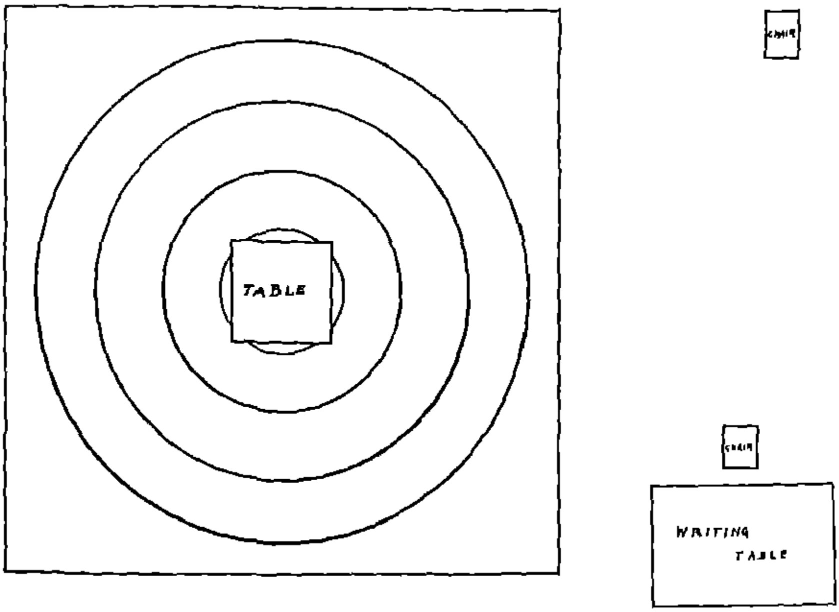

FIG. 7. ILLUSTRATION OF SITUATION IN STANDING TEST

Records were made of time when the child moved off the spot, whether he moved forward or backward, of time and distance of later movements, and of what he did with the objects. In case the child asked questions such as "Can I touch him?" he was answered "Yes." In case the child did not act spontaneously he was engaged in a conversation as to "What

is it?" "What would you like to do with it?" "Would you like to have it, or take it home?"

The time limit, in the case of children of slow or blocked reactions, was any length of time as long as the child coöperated or was interested. In case of a flat refusal it was five minutes. In case of a child picking up or carrying the stimulus object about, the test was terminated there.

Two presentations of each stimulus were made in the following order: chicks and frogs the first day, frogs and rabbit the second day, and rabbit and chicks the last day. The objects were presented in their proper cage in the order listed. The second object was brought to the table from behind a screen after the first object had been removed from sight. During this interval the child sat on a chair which was convenient during the whole test and the child could sit down at any time.

A preliminary or introductory test was given to the children in groups of five with the same apparatus. The stimulus object consisted of two stuffed ducklings. The children stood about in a circle. These group reactions were a bit quicker than in the subsequent solitary tests but still guarded, prefaced by "What are they?" Usually three or four approached the object without urging. In this introduction those who did not move spontaneously were urged to do so, to "touch it in turn." The children were also permitted to play games on the oil-cloth in order to reduce the novelty of the circles. Only two children remarked on the circular lines.

Results of the standing test. The findings of this test are considered from three aspects: the most positive-reactions, the first negative reaction, the verbal report with either positive or negative reactions.

Positive reactions. The most positive reaction was considered to consist of a time factor, the time at which the reaction occurred, and spatial and activity factors of where and what was done. These factors were put into five groups on a frequency basis as given in table 6. The reaction was the nearest position or activity at its earliest appearance after exposure of the stimulus.

The most frequent reaction to the chicks was "touching them" or "picking them up," without much improvement in the second trial over the first. Picking up was more frequent on second trial. With the frogs the tendency was to stand alongside, to lean on the table or touch the cage and to touch the frogs. No one tried to pet them, only one tried to pick them up. To the rabbit the reaction was primarily touching and petting or stroking. Three attempts were made to lift him up. Petting increased with the second exposure.

The data given in table 7 show the form of reaction and the time at which the most positive reaction was made. For the chicks the second trial showed a wider range in time before positive reaction and a higher mean time. For the other animals second trials showed a decrease in range and mean. Analysis of the forms of reaction shows that 85 per cent of the responses are contacts with the animals or reaching toward them. These responses are much less frequent to frogs than

to the chicks or rabbits. Certain animals appear to provoke more caution in approach than others. The two cases of picking up the frog were responses of the same child and the same group of children were responsible for the touching response for the small and the big frog. Familiarity with the animal is a prominent factor in the response.

TABLE 6

Most positive reactions and time of occurrence

Sa = alongside, Re = reach for, lean over, shake table, Th = touch, Pk. = petting or picking up. S with a numeral indicates standing at that distance from center as S3 standing 3 feet from the center. In the case of 5 it may mean sitting down or leaning against the wall.

REACTOR	CHICKS, First trial: Reaction	CHICKS, First trial: Second	CHICKS, Second trial: Reaction	CHICKS, Second trial: Second	FROGS, First trial: Reaction	FROGS, First trial: Second	FROGS, Second trial: Reaction	FROGS, Second trial: Second	RABBITS, First trial: Reaction	RABBITS, First trial: Second	RABBITS, Second trial: Reaction	RABBITS, Second trial: Second
W–	S2	165	Pk	25	Th	300	Re	60	S2	105	Pk	180
S	Pk	150	S3	27	Sa	240	S6	180	Sa	315	S5	310
R	S2½	240	Sa	10	S2	180	Sa	00	S5	420	S0	360
U	Th	12	Th	10	Th	12	Th	10	S2½	135	Th	15
F	Th	255	Th	120	Th	165	Re	255	Th	7	Pk	10
B	Th	25	Pk	90	Th	340	Th	60	Pk	90	Pk	50
C	Th	15	Pk	180	S1	70	Sa	10	Pk	150	Th	20
N	Th	12	Pk	60	Th	15	Th	120	Th	15	Pk	15
O	Pk	55	Pk	65	Th	140	Th	15	Pk	140	Th	25
T	Pk	35	Pk	5	Pk	15	Pk	60	Pk	40	Pk	10
V	Pk	40	Pk	10	Re	15	Sa	25	Th	180	Pk	10
A	Pk	20	Pk	35	Th	45	Th	20	Th	375	Pk	135
M	Th	35	Th	150	Sa	63	Sa	5	Pk	45	Pk	30
E	S2½	150	Th	30	S2	10	S2	105	S3	285	S3	120
H	Th	45	Pk	25	S1	10	Th	20	Pk	120	Pk	40
L	Pk	25	Pk	10	Sa	5	Sa	150	Pk	05	Th	12
K	Pk	120	Pk	20	Sa	7	S2	20	Pk	15	Pk	5
Q	Pk	35	Th	30	Sa	5	Sa	10	Th	300	Pk	100
P	S1	7	Th	25	Sa	5	Sa	5	Pk	180	Sa	120
D	Pk	15	Pk	20	Th	15	Th	90	Pk	50	Pk	15
Range of time......	7–255		10–275		5–360		5–255		7–420		5–300	
Mean time...	72.8		47.3		85.8		65.5		156.1		79.1	

Negative reactions. Negative reactions were reactions made when the subject moved body away from the stimulus. The hand movements away from the objects after single or successive touches or strokes are not included although they occurred frequently, too frequently to be recorded with accuracy.

The negative reactions must be divided on the basis of the stimulus as being quiet and as being active or

moving, hopping or flying. On this basis of comparison the negative reactions may be divided as follows:

STIMULUS	NUMBER OF RETREATING REACTIONS	
Rabbit	quiet 16	moving 4
Frogs	quiet 19	jumping 15
Chicks	quiet 10	flying 3

It must be noted that the rabbit moved his head about at every trial and likewise the frogs climbed or tugged at a 10-inch leash in every case. When the chicks began to fly out younger ones were substituted, but the chicks pecked and moved about in the cage incessantly. Moving includes on the part of the stimuli hopping, climbing, scratching the board by the rabbit and flying. The negative reactions occurred when the animals jumped, scratched or flew. In these cases the reaction was immediate and uniformly so as far as could be observed. Other reasons for withdrawal were to speak to experimenter, to sit in a chair, to look out the window, to get the covering cloth to cover animals, "to get a stick."

TABLE 7

Frequency of reaction types

TYPES OF REACTIONS	TO CHICKS	TO FROGS	TO RABBIT	TOTAL
Picking up	21	2	22	45
Touching	13	15	9	37
Reaching	0	3	0	3
Standing alongside	1	13	2	16
At 1 foot	1	2	0	3
At 2 feet	3	4	2	9
At 3 feet	1	0	2	3
At 4 feet	0	0	0	0
At 5 feet	0	0	2	2

It may be said that there is a limit to tolerance of the stimulus perhaps due to fatigue or summation of negative factors. The test was cut off in those cases and when the child picked up the animals. In the latter case there was no possibility for fatigue or negative summation. Table 8 illustrates the relative frequency and distances to which the children withdrew from the stimuli. The frogs caused more negative reactions than the other two stimuli combined and also occasioned the most distant withdrawals.

TABLE 8

Frequency of negative reactions at varying distances

DISTANCE AT	RABBIT	FROGS	CHICKS	TOTAL
1 foot	0	1	0	1
2 feet	2	1	0	3
3 feet	7	7	2	16
4 feet	0	7	2	9
5 feet	5	6	5	16
6 feet	2	2	0	4
Experimenter	2	8	2	12
8 feet	0	0	1	1
Total	18	32	12	62

On the probability that animal movements occurred as frequently with the older as with the younger children it appears that the younger made more negative reactions than the older. Among the older children 8 were negative to the frog, 6 to the rabbit and 3 to the chicks, 1 to none of them. Among the younger, 10 were negative to the frog, 7 to the rabbit, 7 to the chicks.

Verbal report. Language expression was of two kinds, spontaneous and requested. The requested was in re-

sponse to the following queries: "Would you like to touch, (play with or see) it?" "Would you like to have (or be given) it?" "Would you like to take it home?" Answers of "Yes" or an affirmative headshake are considered a positive answer; "No," or a negative headshake are considered a negative answer. Spontaneous report is expression arising freely from the child without intervention or in reply to "What do you think about it?"

Spontaneous reports included cases of the following: "I'm afraid," "I like," "I wish I had," "He's good, I'd like to take home," "He's all right," "Pretty," "I don't like those," "I don't know," "Let's kiss 'em," "I wouldn't take 'em." There were 30 such spontaneous expressions.

The verbal report was considered in relation to the position of the child at the time. Obvious cases of doubtful expression occur. Similarly the problem of where to mark near and far is not easy to solve. The writer has considered near to mean alongside and within one foot away from the animal which is within easy reaching distance. The responses are summarized as follows:

	CHICKS	FROGS	RABBIT	TOTAL
Positive near	24	7	19	50
Negative near	1	8	1	10
Positive far	0	0	0	0
Negative far	8	18	8	34
Doubtful cases				6

As is evident above 50 per cent of *the reactions consisted of positive* expressions while near the stimulus and 34 per cent of the reactions consisted of negative expressions while relatively far from the stimulus. This gives 84 per cent of the cases in which bodily proximity concomitantly accompanies positive tendencies or attitudes and bodily distance accompanies negative tendencies or attitudes. Of special significance is the absence of any affirmative expression coincident with a distant position. Of the 10 cases which disagree with the general findings 8 of these pertain to frog stimuli which are complicated by wetness and odor.

A summary of the results for the condition of freedom of movement by the child toward or away from animals that are restricted in space shows that 85 per cent of the responses are approach, including reaching toward, touching, and picking up the animal. These responses vary in frequency for different animals. These variations appear to be due in part to the size of the animal and to the amount of activity of the animal. Verbal reports also show that the approach reactions are accompanied by expressions of desire for possession and withdrawal reactions are accompanied by expressions that indicate a desire to avoid nearness or contact with the animal.

Though the negative reactions are much less frequent under conditions of freedom of movement there are individual differences among children in the degree of emotion manifested. The spatial factor of distance from the stimulus correlates closely with the type of reaction made though in a few cases *the movements of the animal* cause withdrawal reactions after contact has been made.

GENERAL CONCLUSIONS

In a study of spatial factors as influential upon emotional responses two situations were presented. In one the child was restricted and five animals, used as stimuli were moved toward or away from the child. In the other situation, the child was free to move and the animal was restricted in space. Seeking or approach responses occurred much more frequently when freedom of movement was permitted the child.

Analysis of results for consistency in types of movements under conditions of the first situation shows a high percentage of concomitant variation in forward and backward movements to approaching or receding stimuli. The most frequent relation found was withdrawal from a coming animal and pursuit of the animal going away.

The shifting in reactions of children to the changing movements of the animal shows that not only movements but direction of movements in relation to the position of the child are influential upon these reactions. An approach toward the animal seemingly a manifestation of curiosity often changes to withdrawal as the animal comes close to the child. As the animal moves away sustained withdrawal often changes to an approach.

In both situations different animals elicited different reactions. Size and activity of the animal, familiarity, and distance from the child were influencing factors. In a state of freedom of the child to move as he desired contacts with the animal, near contacts such as reaching toward it, and approaches to nearer positions were more frequent for all animals than under restriction of movement of the child.

With restriction of movement of the child the forward and backward movements as measured by the ventral and dorsal pressure variations show greater responsiveness of an emotional type than less controlled observations would indicate. Restriction of the child in space often occasions emotion. With the addition of an approaching animal we have behavior that indicates varying degrees of emotion. Verbal expressions reënforce the conclusion that concomitant variations in the responses to moving stimuli offer a valuable method of study of emotion in children.

The modification of responses with successive presentations may show adjustment to the experimental conditions. The decrease in avoidance reactions and in speed or violence of such reactions as indicated by the pressure variations leads to the conclusion that there is a reduction in the emotion aroused. The avoidance reactions that are usually assumed to indicate fear are modified and the seeking reactions are more frequent, and more pronounced. This would indicate a modification from one form of emotional behavior into another.

There are marked individual differences among children in the responses made in both experimental situations. Some do not progress beyond a retreat response though the extent or degree of avoidance is decreased. Others progress rapidly from withdrawal to approaching reactions and attempts at possession. The pressure variation

method showed lack of concomitance with excessive movement indicating a state of incoördination for some individuals. In other cases the response was primarily a rigid posture, and the records give no indication of the reaction tendency. Verbal reports and similar responses in the other test with freedom of movement indicate that these posture reactions show negative or withdrawal tendencies.

A practical implication of this study is that the adjustment of a child to situations that provoke undue emotion is best made under conditions in which he has freedom in response except for the continued presence of the stimulus that arouses emotion. With successive presentations it may be expected that the emotion will be reduced and the behavior will be modified into more desirable forms.

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A Brief Report of the Responses of Preschool Children to Commercially Available Pictorial Materials

Elizabeth E. Olney and Hazel M. Cushing

Many statements have been made in the literature concerning the characteristics of pictures which hold an appeal for children of the preschool levels. Illustrations of familiar objects, of the child's everyday experiences, of animals, other children, automobiles, boats, trains, and airplanes; pictures simple in design, clear in outline; pictures containing color and action; pictures with little detail and little or no background, are among those cited as of especial interest to young children.

In the study here reported the attempt was made to investigate the reactions of 36 nursery school children to different types of pictures frequently found in books for young children. No effort was made to control all the characteristics of the materials presented. The stimulus quality of the latter was rather of the 'gestalt' variety which is identical with the everyday experiences of the child.

Sixteen sets of pictures, culled from a wide selection of children's picture books, were so arranged that each set contained four pictures of similar size, content, and treatment. Nine of the sets were colored and seven were uncolored. The materials were uniformly mounted on stiff gray cards and presented in 4 parallel series, a, b, c, d, each series containing one picture from each set, or 16 pictures. The 4 series were presented at intervals of from five to eight days in order to cancel any loss of interest through recency of presentation. The order of presentation was rotated with eachsubject in order to eliminate the effect of loss of interest through fatigue.

The reliability of the material, ascertained by correlating series a and b against series c and d, was found to be .62 ±.07 which was raised to .77 by application of the Spearman-Brown prophecy formula.

The following is a description of the sets:[1]

1. A set of toys (colored) (simple outline, no background).
   - automobile
   - train
   - doll
   - aeroplane
7. An identical set of toys (uncolored).
8. A set representing animal activities (colored, simple outline).
   - rabbits eating
   - dog and cats drinking milk
   - pigs eating
   - dogs looking into a mirror

[1] Numbers refer to the order of presentation in the series.

2. An identical set representing animal activities (uncolored).
3. A set of silhouettes with a rather fantastic treatment (colored[1]).
   - sailboat
   - elfin blowing a horn
   - children at the beach
   - elfins at play
11. An identical set of silhouettes in black and white.
12. A set of complex compositions (colored, rather sophisticated treatment).
   - children getting dressed
   - children saying their prayers by the bed
   - children swinging
   - children eating their supper
13. A set of mechanical subjects plus the human element (colored, considerable background).
   - people starting off for an aeroplane ride
   - people in a boat
   - men and engine in the roundhouse
   - people starting off in an automobile
14. A set of photographs of everyday objects from a well-known picture book (uncolored).
   - cup of milk and plate of buttered bread
   - chair with a doll beside it
   - wash bowl with soap, glass and toothbrush on it
   - blocks
9. A set of photographs of the objects in the above set with a human element introduced into the situation
   - girl drinking milk
   - girl sitting in chair holding a doll
   - boy washing his hands
   - girl playing with blocks
15. A set representing child activities (colored, very little background).
   - boy riding a velocipede
   - boy riding a cart
   - boy playing with a ball
   - boy building with blocks

[1] The background is colored.

5. An identical set representing child activities (uncolored).
10. A set of small animals (colored, no background).
   - cow
   - horse
   - sheep
   - dog
16. An identical set of small animals (uncolored).
4. A set of large animals (colored, very little background).
   - cow
   - horse
   - sheep
   - dog
6. A set of mechanical vehicles (colored, practically no background).
   - automobile
   - aeroplane
   - steamship
   - train

After considering various possible criteria of interest reported in several somewhat similar studies it was decided to use the objective measure of length of time spent in looking at each picture as the measure of a child's interest. A stop watch, kept concealed by the experimenter, was used for this purpose. A criterion for cessation of interest was empirically determined.

Of the 36 children who served as subjects 12 were on the four year level, 22 on the three year level, and only 2 of the group were between two and three years of age.

The sets with the three highest time scores for the group as a whole were set 13, mechanical subjects involving people, set 12, dramatic scenes with children, and set 6, mechanical subjects without the human element. Set 9, photographs of children with everyday objects, and set 15, child activities done with rather simple outline, were next in popularity in terms of the criterion. Sets receiving the lowest

times scores were sets 16, small uncolored animals, set 11, silhouettes in black and white, set 2, uncolored animal activities, set 10, small animals colored. Set 3, silhouettes with colored background, set 8, representing animals activities, and set 4, large animals, also ranked low in interest value as judged by the criterion.

An analysis of results according to age level showed no significant differences on the 2, 3, and 4 year levels. Sets which elicited the prolonged attention of the four year olds were also most potent in producing a lengthened time score for the two and three year olds. Likewise, the sets obtaining lowest scores were practically the same for all these age levels.

Although sex differences in score were not large there was an observable tendency for boys to show a marked preference for pictures involving mechanical objects such as trains, boats, aeroplanes, automobiles, while the first choice of the girls seemed to center around scenes with a strong dramatic element.

In spite of the fact that the number of cases involved in the study was not large (36), certain trends stand forth rather clearly with the particular group of children concerned.

Mechanical objects had a high interest value in terms of the criterion. The introduction of the human element whether of adults or children enhanced the value of all types of pictures. Animals, whether portrayed individually or in groups came surprisingly low on the scale. Whether this preference in the direction of the mechanical would obtain with children in a rural type of environment has not been determined. If it is, to a certain extent, true that one's preferences are genetic in origin, i.e., that we tend to like that to which we become accustomed, it is possible that interest in animal life might be dominant in a non-urban group of children. This assumption cannot be made, however, without further experimental evidence.

In checking picture books found in the homes of the children who served as subjects in this study, it was found that over three quarters owned animal books, while but one quarter had access to pictures of mechanical objects and that fewer still had pictures involving children and everyday objects and experiences. Books of all these various types, however, were available to the children in the nursery school environment. It would seem in the light of these findings that possibly adults should reverse their procedures in selecting picture books for children at least in urban communities, and provide the mechanical and dramatic pictures, as well as those of animals.

Complexity of detail and even fantastic treatment did not seem to be a bar to interest, providing the picture had inherent dramatic quality. Background or lack of background did not seem to be a determining factor in the amount of time spent in looking at a picture even with the youngest children.

When 5 colored sets were compared with their 5 uncolored counterparts, it was found that color enhanced the interest value of the pictures to a considerable degree.

Silhouettes, despite their artistic merit, at least for the child of nursery

school age, would seem to have less attention value than other types of treatment.

Comparing scores for large and small animals it was found that the former are more potent from the child's point of view.

The differences reported above were found to be reliable when sample pairs were tested statistically by the formula for determining the reliability of differences.

In the light of these tentative conclusions, the value of any picture book for the young child should not be minimized. Many books are particularly valuable as incentives to the development of vocabulary, where the adult points out the object and gives the appropriate word. It is probable, however, that a desirable procedure would be that in which first hand experiences preceded the introduction of pictures built around those experiences and that as the activities of the child expand in scope, new pictorial material might well be introduced which would serve to recall and vivify the experience. Actually such does not seem to be the common practise either at home or in school.

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The Effect on Behavior of Variation in the Amount of Play Equipment[1]

MARGUERITE WILKER JOHNSON

CONSIDERABLE information on childhood play is now available. Investigations have afforded data as to types of occupations in which children engage, kinds of play materials used, time spent in different activities, types of social participation and sex and age differences. More than a hundred such studies have recently been classified by Hurlock (3).

Similar tendencies in play behavior have been noted in situations that are somewhat alike. Few direct comparisons, however, have as yet been attempted with experimental variations in play equipment in the same or comparable groups of subjects. There is need for more specific information as to the advantages and disadvantages of different types of play situations. Are children, for example, more active, more resourceful, and more sociable on generously or on meagerly equipped playgrounds? How does play behavior vary when the same playground is variously equipped? These questions have prompted the present study.

The problem was to compare the activities of the same children on the same playground before and after a change occurred in the play equipment. Three separate studies have been made on three different playgrounds. Two surveys of the same group of children were made on each of these three playgrounds, once before and once after a variation occurred in the play equipment.

One group of children was accustomed to considerable equipment. This group was observed at regular play and again after considerable play equipment had been removed. The other two groups were accustomed to much less equipment. Each of these groups was observed at regular play and again after considerable new play equipment had been introduced. The report for each group will be presented separately and the general implications will then be considered (4).

[1] From the child development laboratories of the University Elementary School of the University of Michigan. The observers were: For the three-year-olds, Mrs. Samantha Cleminshaw; for the four-year-olds, Miss Mary Louise Hohn; for the five-year-olds, Miss Kathryn Purcell. The writer is indebted to Mrs. Minnie Arnold, principal of the schools, who made the observations in public schools. Some of the data are summarized in her unpublished M.A. thesis (1).

I. THE EFFECT OF A REDUCTION IN PLAY EQUIPMENT ON THE BEHAVIOR OF THE CHILDREN ON THE UNIVERSITY ELEMENTARY SCHOOL PLAYGROUND

Two series of observations of the play activities of the same children were made on the University Elementary School playground to discover the effect of the removal of considerable play equipment on the play behavor of the children. The general principles developed in time-sampling studies were employed in the initial and final observations (5). Each series consisted of 21 observations for each child, one made in each five-minute unit of time and seven made on each of three days. The detailed instructions for observing and recording were as follows:

"Begin at 9:30 o'clock, Monday, April 24, 1933. Look at the first child on the list. Take time to decide what he is doing. Pay no attention to any other child. Record a symbol opposite the name to show what he is doing. If he is playing with others, use a figure to note the number of his companions. Proceed to the next child and do the same, and continue down the list. Then rest until the end of that five-minute period."

"Begin again on the second five-minute interval at the top of the list and go down the list in the same way. Continue for seven periods of five minutes each, a total of 35 minutes each day."

"Repeat on Tuesday, April 25, and again on Wednesday, April 26."

"While recording take an advantageous position and keep it throughout, except when it is necessary for you to move to locate a child."

The first survey was made on the first three days of the week. The experimental materials were then removed during the week-end and the second survey was made on the first three days of the following week. In addition to the eye-witness surveys the playground was photographed every five minutes. The results of the photographic work are to be published in a separate paper (6).

The regular playground was equipped with two stationary slides, one medium and one small, one baby junglegym, two swings, one large sand pit with sand toys, one stair climbing apparatus with platform, one movable slide three feet wide and three feet long, one rocking boat, a half dozen tricycles, six kiddy cars, ten Buddy L trucks, six wagons, five wheel barrows, one set of Rathbun out-door building blocks, two large dry goods boxes, four saw horses, six planks, four kegs, six shovels, seven rakes, four spades and six balls of various sizes. After the first survey was made all equipment and materials, except the two stationary slides, two swings, stair climbing apparatus, junglegym and sand pit were removed from the playground. For convenience the articles that were withdrawn will be referred to as the experimental materials.

The report is based upon observations of 33 children, 18 boys and 15 girls who were enrolled in three age groups as shown in table 1. One of the two regular teachers for each group was in charge of the children while the other teacher was engaged in making the observations. The children were accustomed to this type of situation since one teacher was always free in regular practice to give any needed assistance while the other teacher was engaged in routine work.

TABLE 1

Outline for three studies of the effects of variation in play equipment on the behavior of children

STUDY	SUBJECTS	INITIAL OBSERVATIONS	EXPERIMENTAL VARIABLES	FINAL OBSERVATIONS	COMPARISONS
I. University Elementary School Playground, April, 1933	Age, September 1, 1932 Mos. 36 48 60 T B 5 8 5 18 G 2 7 6 15 T 7 15 11 33	(1) 21 records per child (one record for each child in each 5-minute period for 7 periods on each of 3 days). Code recording of activities (2) 7 photographs of playground each 5-minute period	Removal of Equipment 1 Movable Slide 1 Basket of Sand Toys 1 Rocking Boat 33 Vehicles 6 Shovels, 7 Rakes, 4 Spades 6 Balls 1 Set Rathbun Blocks 2 Dry Goods Boxes 6 Planks 4 Kegs 4 Saw Horses	Duplicate of initial observations	Amounts and types of activities before and after the removal of equipment. Sex differences. Age differences
II. Public School A Playground, Jackson, Mich., May, 1932	Average age, September 1, 1931 Months 60 ±4.7 B 24 G 22 T 46	(1) 12 records per child (one record each 5-minute period for 3 periods on each of 4 days). Code recording of activities	Introduction of Equipment Building Blocks 2 Boxes 2 ft. x 5 ft. 2 Boards 5 ft. long 2 Wooden Horses 1 Barrel 7 Wooden Wheels 4 Iron Rods	Duplicate of initial observations	Amounts and types of activities before and after the introduction of equipment. Sex differences. Age differences
III. Public School B Playground, Jackson, Mich., April, 1933	Average age, September 1, 1931 Months 63 ±2.0 B 15 G 14 T 29	(1) The same as for Public School A	Introduction of Equipment (as above) Boxes Boards Barrel Wheels and Rods	Duplicate of initial observations	Same as above
Total..................	B 57 G 51 T 108	45 units of observations		45 observations	

The specific activity records have been classified in broader categories as needed for the exposition of the experimental variations and the trends of evidence. The larger categories for classification are as follows, bodily exercise, play with materials, undesirable behavior, games and contacts with the teachers. Bodily exercise includes vigorous gross motor activity such as swinging, running, sliding, climbing and jumping and less vigorous activities such as talking, shouting, walking, sitting, standing, looking and listening. Play with materials has been subdivided into play with permanent material (manipulation of sand and dirt), and play with experimental materials (the use of vehicles, shovels, rocking boat, balls and building materials). The categories, their symbols and the results are shown in table 2. The statistical treatment is in terms of the number and per cent of the total child-observations which fell in each category.

The trends found for the larger categories appear to be significant. The number of children and the observation involved, however, are not sufficient to establish with certainty the reliability of the trends found for the specific items. A correlation (Spearman Rank Difference) of .77 (converted r .78 ±.06) represents the agreement between the relative frequencies of activities on the playground before and the activities on the playground after the removal of play materials when those items occurring in only one situation are excluded. It will be seen that in spite of quantitative variation in the amount of certain activities the relative proportions remain somewhat constant.

Even though the same general tendencies are noted in both the regular and the reduced situations some important differences in behavior appear. Bodily exercise is decreased in amount (table 2) from 61.2 ±1.8 per cent of all activities before to 49.7 ±1.8 per cent of all activities after the removal of play equipment, a significant decrease of 11.5 ±2.4 per cent. The decrease occurs chiefly in connection with vigorous exercise (8.7 ±3.0 per cent) while the less active types of exercise such as walking, talking, sitting, standing appear to be about the same in amount both before and after the removal of play materials.

The decrease in the amount of bodily exercise would be much greater if those items classified under experimental materials were classified instead under bodily exercise as they represent considerable activity. Since, however, the general trends are the same in either classification, the items dealing with the experimental materials are reported here under the separate category.

Play with materials is increased after the removal of the experimental materials from 34.9 ±2.0 per cent to 39.5 ±1.9 per cent of all activities. This increase of 4.6 ±2.8 per cent in total amount is not statistically significant but the change in the nature of play in the two situations is of importance. Play with vehicles, shovels, balls, rocking boat and building materials comprise 27.3 ±2.1 per cent of all activities before and none of the activity after the materials are with-

TABLE 2

Play activities before and after a reduction in play equipment

Number of girls 15, boys 18

ACTIVITIES	SYMBOL	NUMBER OF OCCURRENCES						PER CENT		D	D/PE$_d$
		Before		After		Total					
		Boys	Girls	Boys	Girls	Before	After	Before	After		
Bodily exercise:											
Vigorous:											
Swing	Sw	26*	50	27	45	76	72	11.0	10.4		
Run	R	24	17	21	16	41	37	5.9	5.3		
Slide	Sl	20	13	22	5	33	27	4.8	3.0		
Climb	C	37	21	14	7	58	21	8.4	3.0		
Junglegym	G	17	9	0	4	26	13	3.8	1.9		
Jump	J		2	0	1	2	7	0.3	1.0		
Less active:											
Walk	W	12	21	16	7	33	23	4.8	3.3		
Talk	T	21	21	28	23	42	51	6.1	7.4		
Sit	S	14	15	14	33	29	47	4.2	6.8		
Stand	St	22	28	7	17	50	24	7.2	3.5		
Look	L	17	9	12	5	26	17	3.7	2.5		
Shout	Sh	2	5	3	2	7	5	1.0	0.7		
Listen	Li		1	1		1	1	0.1	0.1		
Total vigorous		124	112	99	78	236	177	34.2	25.5	8.7 ±3.0	2.6
Total less active		88	100	81	87	188	168	27.1	24.2	2.9 ±3.0	0.0
Total exercise		212	212	180	165	424	345	61.2	49.7	11.5 ±2.4	4.7
Play with materials:											
Permanent:											
Sand	Sa	20	29	87	86	49	173	7.1	24.9		
Dirt	D	4		74	27	4	101	0.6	14.6		
Experimental:											
Vehicles	V	85	47			132		19.0			
Shovels	Sh	30	1			31		4.5			
Balls	Ba	11	4			15		2.2			
Rocking boat	Ro	3	5			8		1.2			
Building materials	B	1	2			3		0.4			
Total permanent		24	29	161	113	53	274	7.7	39.5	31.8 ±3.1	10.3
Total experimental		130	59			189		27.3		27.3 ±2.1	13.0
Total materials		154	88	161	113	242	274	34.9	39.5	4.6 ±2.8	1.6

* One item represents one record in one five-minute interval of time, 26 represents the number of items of swinging in a total of 378 records for boys.

TABLE 2—*Concluded*

ACTIVITIES	SYMBOL	NUMBER OF OCCURRENCES: Before, Boys	Before, Girls	After, Boys	After, Girls	Total, Before	Total, After	PER CENT: Before	PER CENT: After	D	D/PE$_d$
Undesirable behavior:											
Tease	Ts	3		7	2	3	9	0.4	1.3		
Cry	Cr	1	2	5	3	3	8	0.4	1.2		
Quarrel	Q			3	1	0	4		0.6		
Hit	H	1		2		1	2	0.1	0.3		
Total undesirable		5	2	17	6	7	23	0.9	3.4	2.5	
Games	Ga			6	21	0	27		3.0	3.0	
Teacher contacts	TC	1	2	5	3	3	8	0.4	1.2	0.8	
Temporary absence	A	6	11	9	7	17	16	2.5	2.3	0.2	
Total child observations†		378	315	378	315	693	693	99.9	99.9		

† The number of children in a sample multiplied by number of observations of each child.

drawn. Play with sound and dirt (permanent materials) amounts to 7.7 ±2.4 per cent of all occupations before and 39.5 ±1.9 per cent after the reduction in play materials, a significant increase of 31.8 ±3.1 per cent.

Games are not present in the well-equipped situation and undesirable behavior constitutes but one per cent of all activity. Games, however, are in evidence on the reduced playground and comprise 3.9 per cent of the records with undesirable behavior showing an increase of 2.5 per cent. The total number of contacts with the teacher are few and they are increased after the materials are removed. The temporary absences both before and after amount to 2 per cent of the records.

Even though the amount of undesirable behavior is relatively small in quantity as compared with other activities it may, nevertheless, be very significant and is therefore presented in greater detail in table 3. The total amount of undesirable behavior is represented by 23.3 per cent before and 76.6 per cent after reduction in play materials, a total increase of 53.3 per cent. Crying, teasing and quarreling occur oftener especially with boys in the three and five year old groups.

Few conclusions concerning sex and age can be drawn with such small figures. In general, however, girls exceed boys (table 2) slightly in the total amount of exercise while boys tend to exceed girls in the use of materials and in undesirable behavior. When the playground is reduced girls engage in more games and boys in relatively more undesirable behavior.

An analysis by age (table 4) indicates that the five-year olds engage on the average in more bodily exercise before the play materials are removed than the three or four-year olds while

TABLE 3

Undesirable activity before and after a reduction in play equipment

Number of girls 15, boys 18

	NUMBER OF OCCURRENCES												PER CENT OCCURRENCES		
	3 years			4 years			5 years			All children			All children		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Before															
Tease	2		2	1		1				3		3	13.6		10
Cry		2	2	1		1				1	2	3	4.6	25.0	10
Quarrel															
Hit				1		1				1		1	4.6		3.3
After															
Tease	1		1	1		1	5	2	7	7	2	9	31.8	25.0	30
Cry	4	1	5				1	2	3	5	3	8	22.7	37.5	26.7
Quarrel	1	1	2				2		2	3	1	4	13.6	12.5	13.3
Hit	1		1	1		1				2		2	9.0		6.7
Total before	2	2	4	3		3				5	2	7	22.7	25	23.3
Total after	7	2	9	2		2	8	4	12	17	6	23	77.2	75	76.6
Difference in favor of the reduced playground													54.5	50	53.3

TABLE 4

Age difference in play activities before and after a reduction in play equipment

	NUMBER OF OCCURRENCES						MEAN NUMBER PER CHILD					
	Before			After			Before			After		
	Age in years											
	3	4	5	3	4	5	3	4	5	3	4	5
Bodily exercise	94	174	156	78	173	94	13.4	11.6	14.2	11.1	11.5	8.5
Play with materials:												
Permanent	8	27	18	46	134	94	1.1	1.8	1.6	6.6	8.0	8.5
Experimental	36	105	48				5.1	7.0	4.4			
Undesirable behavior	4	3		9	2	12	0.6	0.2		1.3	0.1	1.1
Games				3	2	22				0.4	0.1	2.0
Teacher contacts	3			4	1	3	0.4			0.6	0.1	0.3
Temporary absence	2	6	9	7	3	6	0.3	0.4	0.8	1.0	0.2	0.5
Number of child observations	147	315	231	147	315	231	21	21	21	21	21	21
Number of children	7	15	11	7	15	11	7	15	11	7	15	11

the four-year olds make more use of materials. When the playground is reduced all groups tend to occupy themselves slightly less with exercise,

more with sand and dirt, more with games and undesirable behavior, the noticeable differences in these directions appearing in the five-year old group.

The number of social contacts (table 5) is significantly increased 26.7 ±3.4 per cent on the reduced playground with an absolute increase occurring in connection with each type of behavior. Relative differences, however, expressed in terms of the per cent of all occurrences before and the per cent of all occurrences

TABLE 5

Social contacts before and after a reduction in play equipment

	Sex	Number of occurrences										Per cent occurrences		D	PE_d
		Before			After			Total		Total		All children			
		Age													
		3	4	5	3	4	5	Before	After	Before	After	Before	After		
Bodily exercise	B	29	16	30	29	37	10	74	76						
	G	14	10	32	16	28	14	56	57	130	133	68.4	40.4	28.0 ±3.9	7.2
Permanent materials	B	14		9	21	22	45	23	88						
	G	2	2	6	6	23	26	10	55	10	143	10	43.3	33.4 ±5.4	6.2
Experimental materials	B		2	7				9							
	G	1		9				10		33		17.3		17.3 ±4.4	3.9
Undesirable behavior	B	2	1		6	1	7	3	14						
	G	2			2		2	2	4	5	18	2.6	5.4	2.8	
Games	B				1	1	4		6						
	G				2	1	18		21	0	27		8.2	8.2	
Teacher contacts	B	1			2	1	2	1	5						
	G	2			2		1	2	3	3	8	1.5	2.4	0.9	
Total contacts	B	46	18	46	59	62	68	110	189						
	G	21	12	47	27	52	61	80	140	190	329	99.8	99.8		
Number of children	B	5	8	5	5	8	5	18	18						
	G	2	7	6	2	7	6	15	15	33	33				
Mean number of social contacts	B	9.2	2.2	9.2	11.8	7.7	13.6	6.1	10.5						
	G	10.5	1.7	7.8	13.5	7.4	10.1	5.3	9.3	5.7	9.9				
Per cent of all social contacts	B							21.2	36.4	36.3	63.3			26.7 ±3.4	7 8
	G							15.4	26.9						

after indicate considerable change in the nature of the contacts made after the play materials are removed. Social play is increased 33.4 ±5.4 per cent in play with materials (sand and dirt) 2.8 per cent in undesirable situations and 8.2 per cent in games at the same time that it is relatively and significantly decreased 28.0 ±3.9 per cent in connection with bodily exercise. An analysis of social contacts by age and sex indicates that boys tend to make more contacts than girls, the mean number being respectively for boys and girls 6.1 and 5.3 before and 10.5 and 9.3 after removal of materials. Boys exceed girls in the number of contacts made in bodily exercise, in play with materials and in undesirable behavior while girls exceed boys in the number made in games. Four-year old boys and girls make fewer average social contacts than three and five-year olds.

In general, then the University Elementary School is characterized after the reduction of play materials by less bodily exercise, more play with sand and dirt, more games, more undesirable behavior and a greater number of social contacts than are noted on the playground when the experimental materials are present. Dow (2) reports "there is more material and non-social play on equipped playgrounds and more non-material and social play on unequipped playgrounds."

II. THE EFFECT OF THE INTRODUCTION OF CONSIDERABLE PLAY EQUIPMENT ON THE BEHAVIOR OF THE CHILDREN ON TWO PUBLIC SCHOOL PLAYGROUNDS

The effect of the introduction of considerable play equipment on the behavior of children was investigated in studies made on two different public school playgrounds at Jackson, Michigan.

The playgrounds, designated here as School A and School B, were first surveyed with the regular equipment and then again after the addition of new play materials. The regular equipment consisted of a sand box and whatever toys the children brought day by day from home. The new materials which were added to each playground before the second survey was made are listed in table 1 with other information concerning the 75 children, 39 boys and 36 girls, their ages, the types of observations and the experimental variables.

The same categories for classification as those used in the University Elementary School are used here. The specific items are similar though not identical as will be seen in the tables. The same general tendencies are present on both playgrounds (table 6). Bodily exercise is decreased in amount after the introduction of new play materials to the extent of 33 ±3.0 per cent of all activities for School A and 17 ±2.6 per cent for School B. Play with materials is increased in the enriched situation 42.1 ±3 per cent for School A and 20.8 ±4.3 per cent for School B. Play with experimental materials is increased very much more than play with permanent materials, the increase for the experimental and permanent materials being respectively 48.0 ±2.0 per cent and 6.0 ± 3.6 per cent for School A and 32.9 ±2.9 per cent and 12.5 ±4.7 per cent for School B. Undesirable behavior and games are decreased in amount on both playgrounds after

TABLE 6

Activities on two public school playgrounds before and after the introduction of building materials

	NUMBER OF OCCURRENCES				SCHOOL A		SCHOOL B		SCHOOL A		SCHOOL B	
	School A		School B		Per cent		Per cent					
	Before	After	Before	After	Before	After	Before	After	D	PE_d	D	PE_d
Bodily exercise:												
Vigorous:												
Run	74*	23	64	26	13.4	4.2	17.9	7.4				
Skip	21	30	74	70	3.8	5.4	20.7	22.0				
Jump	15	2	6	3	2.7	0.4	1.8	0.8				
Climb	5	3	20	21	0.0	0.5	5.6	6.0				
Less active:												
Stand	143	61	87	56	25.9	11.0	24.3	10.0				
Sit	52	13	8	16	9.4	2.4	2.2	4.5				
Walk	13	9	29	21	2.4	1.6	8.1	6.0				
Total vigorous	115	58	164	129	20.8	10.5	45.8	36.8	10.3 ±3.7	2.8	9 ±3.8	2 4
Total less active	208	83	124	93	37.7	15.0	34.6	26.5	22.7 ±3.4	6.7	8.1 ±4.2	2
Total exercise	323	141	288	222	58.5	25.5	80.4	63.4	33.0 ±3.0	11.0	17.0 ±2.6	6.5
Materials:												
Permanent:												
Sand	25	54	46	7	4.5	9.9	12.9	2.0				
Broom	21	5	0	3	4.0	0.9	2.5	0.9				
Wagon	13	11			2.3	2.0						
Garden	1	18			0.2	3.3						
Horse	18				3.2							
Rake	13				2.3							
Ball	9				1.6							
Shovel	8				1.4							
Leaves	7				1.3							
Truck		7				1.3						
Doll cab	5	1			0.9	0.2						
Miscellaneous	11	2	2	2	2.0	0.4	0.6	0.6				
Experimental building materials		265		115		48		32.0				
Total permanent	131	98	57	12	23.7	17.8	16.0	3.5	6.0 ±3.6	1.7	12.5 ±4.7	2 7
Total experimental		265		115		48		32.9	48.0 ±2.0	24.0	32.0 ±2.0	11.3
Total materials	131	363	57	127	23.7	65.8	16.0	36.3	42.1 ±3.0	14.0	20 3 ±4 3	4.7

* One item represents one record in one five-minute interval of time, 74 represents the number of items of running in a total of 552 records. There were 40 children in School A and 20 children in School B.

TABLE 6—*Concluded*

	NUMBER OF OCCURRENCES				SCHOOL A		SCHOOL B		SCHOOL A		SCHOOL B	
	School A		School B		Per cent		Per cent					
	Before	After	Before	After	Before	After	Before	After	D	PE_d	D	PE_d
Undesirable behavior....	18	4	5	1	3.3	0.7	1.4	0.3	2.6		1.1	
Games..................	0	2	8	0	1.1	0.4	2.2		0.7		2.2	
Temporary absences...	74	42			13.0	7.6			5.4			
Total..................	552	552	358	350	99	99	99	99				
Less duplications in recording............			10	2								
Total child observations................	552	552	348	348	99	99	99	99				

the introduction of new materials. The numbers in these categories, however, are too small to determine the significance of the decrease.

The sex differences (table 7) are the same for both types of playgrounds and they agree with those found for the University Elementary School. Girls engage in general in more bodily exercise than boys and boys are more occupied with materials and undesirable behavior. The differences are increased after the addition of play equipment.

SUMMARY AND CONCLUSIONS

Amounts and types of play activities appear to be consistently related in these investigations to types of playgrounds. This is true whether the group has previously been accustomed to considerable or to meager equipment.

Children are very resourceful in all situations, on meagerly as well as on generously equipped playgrounds.

Bodily exercise and play with materials rank high in amount on all playgrounds as compared with games and undesirable behavior and do not seem to be entirely dependent upon extensiveness in equipment.

The same groups, however, when they are more extensively equipped, engage on the same playground in greater amounts of bodily exercise or play with materials and in lesser amounts of undesirable behavior and social play.

The more extensively equipped playground for each group is characterized by a greater combined amount of bodily exercise and play with materials and fewer social contacts in games and undesirable behavior. The less extensively equipped playground for each group is characterized by a lesser combined amount of bodily exercise and play with materials and a greater number of social contacts and social conflicts.

Consistent tendencies are found in that the absence or subtraction of materials is reflected in an increase

in the use of permanent materials whereas the presence or addition of materials is reflected in a decrease in the use of permanent materials. In all instances the presence of equipment reduces games and undesirable behavior such as teasing, crying, quarreling and hitting while the absence of equipment increases games and social contacts.

In general, it would appear that individual endeavour is encouraged while social contact and undesirable behavior are discouraged by the relatively more extensive equipment. From an immediate point of view it may be that individual endeavour can be increased and undesirable behavior decreased by introducing equipment. From a long-time point of view, how-

TABLE 7

Sex differences on two public school playgrounds before and after the introduction of building materials

		NUMBER OF OCCURRENCES						PER CENT OCCURRENCES				
		School A		School B		Both schools		Both schools		*Difference in favor*		D/PEd
		Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
Bodily exercise.....	Before	131	102	134	164	265	346	55.0	70.3		23.4 ±2.5	0.4
	After	36	105	82	140	118	245	25.2	56.4		31.2 ±3.4	0.2
Permanent materials............	Before	95	36	41	16	136	52	28.6	11.9	16.7 ±3.9		
	After	57	41	10	2	67	43	14.3	9.9	4.4 ±4.2		
Experimental materials............	Before											
	After	172	93	87	28	259	121	55.3	27.8	27.5 ±3.3		8.3
Undesirable behavior...............	Before	17	1	4	1	21	2	4.4	0.4	4.0		
	After	2	2	1	0	3	2	0.6	0.5	0.1		
Games..............	Before		6	7	1	7	7	1.5	1.6		0.1	
	After		2				2		0.5		0.5	
Temporary absences.	Before	45	29			45	29	9.5	6.7	2.8		
	After	21	21			21	21	4.5	4.8		0.3	
Total occurrences...	Before	288	264	186	172	474	436					
	After	288	264	180	170	468	434					
Less duplications in recording.........	Before			6	4	6	4					
	After			0	2	0	2					
Total occurrences...	Before	288	264	180	168	468	432	99.9	99.9			
	After	288	264	180	168	468	432	99.9	99.9			
Number of children..		24	22	15	14	39	36					

ever, too much equipment may greatly interfere with social development. On all playgrounds the total number of social contacts is accompanied by relatively few social conflicts. Social conflict should be studied in the light of its educational contribution to social development.

In conclusion, the amounts and types of play equipment need to be further investigated and understood as to their functions and values giving attention both to individual and to social growth. The implications of implementation apparently have far reaching significance for the general theories of social development. It may be that investigations of this type in various small groups will serve gradually to clarify certain principles applicable to larger groups and to community relationships.

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Rorschach Norms for an Adolescent Age-Group

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THE Rorschach Ink-blot Test was originally applied to 405 subjects, 117 normal persons of whom 55 were reported "educated" and 62 "uneducated," the others, mentally disordered cases. Tables containing Rorschach's norms for these normal and psychotic groups are presented in the original manual (10, 11). No statistical computations are included in this study; no mention is made of variability in the groups. The figures, based on few subjects and these, for the most part, abnormal, can only be taken as tentative suggestions.

Since the publication of Rorschach's monograph, many studies (2a) have been made on the technique and symptomatic value of the test factors. The method has been applied extensively in various personality studies. In many of these studies, norms for the different test factors and for the respective age-groups examined have been presented, in terms of averages, means, or medians. A review of these shows that many agree to some extent with the tentative norms published by Rorschach for similar groups. The results of many studies agree likewise among themselves. On the other hand, there are many disagreements, often for similar age-groups. The data are not, of course, comparable because of the variety of methods of administration and of scoring employed, and because of other variable factors, such as race and social and economic status.

A few studies of comparatively "normal" children have been reported by *Löpfe* (8) for ages ten to thirteen, *Loosli-Usteri* (7) ages ten to twelve, *Behn-Eschenburg* (1) for ages thirteen to fifteen, *Kerr* (4) seven to fourteen, and *Mira* (9), fourteen to sixteen years. *Behn-Eschenburg* (1) working under the personal direction of Rorschach studied various phases of mental life and changes taking place in the "Erlebnistypus" during adolescence. He applied the test to 209 boys and girls, selected at random in the "Realschule" and "Volkschule" in Zürich. Although the blots used were not the original ones, he reported that they were parallel to them, having been standardized to correspond to the original. Results were computed, and comparisons were made between the different school grades, between the "Realschule" and "Volkschule" and between the sexes.

Löpfe (8), interested in the technical aspects of the Rorschach method and

in its practicality for studying school children, selected subjects from various grades in the "Volkschule" in Zürich and from divers population districts. He established norms for the respective test factors and for his different age-groups. A similar sample was selected by *Loosli-Usteri* (7) from a Geneva public school with the twofold purpose of comparing, first, the Geneva results with those obtained by Löpfe with his Zürich children and second, the children living in an orphan asylum with those living at home.

Schneider (13) also computed norms for his groups of children. He used the Rorschach to study children who were intellectually inhibited. Eighty-seven school children in special classes were given various psychological tests and also the Rorschach. Special study was made of subjects whose scores on the various tests differed widely, the assumption being that these discrepancies were due to defects in personality make-up.

Kerr's norms (4) for 365 English children including mental defectives and child guidance clinic cases have not yet been published. Two Spanish studies by *Linares* (5, 6) are reported containing results for normal children, 50 of each sex, and for feeble-minded and superior children.

Vernon (14) who worked with three adult groups, has summarized the norms of some of the above mentioned studies in a comprehensive table which includes norms for his groups and for other adult and feeble-minded groups.

Because so few norms are available for "normal" children, one of the projects included in the investigation planned by the Brush Foundation was to establish norms for a definite age group which would be statistically reliable and which could be put to practical application in interpreting Rorschach scores. Report (2) has already been made of the standardization of the method of administration of the Rorschach test and of the method of scoring.

Briefly summarizing, after a detailed study had been made of the method employed by Rorschach and of the subsequent changes attempted by other administrators, a preliminary experiment was performed with a "normal" miscellaneous group, an emotionally unbalanced group and a neurotic group. The Rorschach records were scored for certain general test factors and the results submitted to statistical analysis. Results showed satisfactory reliability as judged by the coefficients of correlation obtained by the split-test method. Comparison of groups displayed some differences,—enough to warrant further experimentation with the method.

STANDARDIZATION OF ADMINISTRATION

On the basis of the experiences in the preliminary work, revision was made of certain steps in the procedure to insure standardized conditions and to make the test easier to administer and to make scoring more accurate and more objective. Personal Data Sheets, Record Blanks, and Summary Sheets were prepared for quick and efficient recording of all necessary data. A trial blot was introduced to make the responses to the first card more comparable with the rest and in order to establish a favorable mental

set at the beginning. Systematic and uniform directions were prepared and memorized. Diagrams were made for each blot, parts of the blot being assigned symbols in the form of letters and numbers, for indicating the exact location of the detail selected for interpretation. Symbols were likewise adopted for indicating the position in which the blot was held, and a key to the English scoring symbols was prepared for use. Finally, the reaction time was limited to two minutes per blot.

The test was given to 300 students of the Patrick Henry Junior High School, 150 boys and 150 girls, selected as representative of average American-born white children. They were selected at random as to chronological age, class standing and school grade. Attempts were made, however, to see that the subjects represented as far as was possible an even distribution according to mental capacity. Table 1 presents the distribution for boys and girls according to chronological age, with the average C.A. for the boys, the girls, and the whole group. The distribution for both boys and girls, and for the group approximate the normal curve.

All the subjects had received the Otis Self-Administering Intermediate Examination, Form B at the Brush Foundation in the course of the two years in which the investigation of the Rorschach Test took place. To insure the accuracy of the Intelligence Quotients obtained on this test, they were checked against the latest ratings of the subjects as recorded on the files of the school. These ratings had been obtained on the basis of other intelligence tests, namely the Otis Form A, the Haggerty Test and the Cleveland Test. A correlation of $+.857 \pm .011$ was obtained, indicating a satisfactory reliability of the intelligence quotients as indicated by the Otis Test, Form B.

TABLE 1

Distribution of Patrick Henry subjects according to chronological age and sex

C.A.	BOYS	GIRLS	TOGETHER
12,6–12,11	11	11	22
13, –13, 5	23	25	48
13,6–13,11	20	31	00
14 –14, 5	27	30	57
14,0–14,11	32	31	63
15 –15, 5	16	14	30
15,6–15,11	0	4	10
16, –16, 5	6	4	10
Total.......	150	150	300
Aver........	14.2	14.1	14.2
SD..........	7.2	9.9	10.26

TABLE 2

Distribution of Patrick Henry subjects according to Intelligence Quotients

LEVEL	I.Q.	BOYS	GIRLS	TOGETHER
Low Average......	70–89	10	11	30
Average...........	90–100	56	59	115
Superior..........	110–110	34	45	79
Very Superior.....	120–130	41	35	76
Total..................		150	150	300
Aver..................		106.7	107.6	107 2
SD....................		15	13 5	14.3

Table 2 shows the distribution of the subjects according to these Intelligence Quotients. The average Intelligence Quotient is 107.2. The distribution also approximates the normal curve. However, the group which was selected as an average group, must be

viewed as a high average group in view of the average Intelligence Quotient. It should be observed that in this group 115 subjects comprised an "average" group in the sense that the Intelligence Quotients ranged from 90 to 109.

Standardization of the scoring method

The Rorschach test records obtained from the group of 300 were subjected to statistical analysis and definite quantitative and qualitative criteria were determined for scoring the different Rorschach factors. Responses were tabulated for each ink-blot and Frequency Tables constructed for the determination of scores in respect to W, D, Dr, Do, F+, F−, O+, O−, I. and P. The scoring method was found to be reliable as judged by the extent of agreement between scores of one judge and those of another on 100 records selected at random.

Reliability of the test in its standardized form. Report has likewise been made of the reliability of the Rorschach test as modified by the Brush Investigation (3). On the basis of 100 records selected at random from the group of 300 students, reliability coefficients of the test factors were computed by the corrected split-half method. Results ranging from .9 to .6 were considered satisfactory.

PROBLEM

After the method of administration and scoring had been determined and the reliability of the test had been satisfactorily determined, the averages for the various test factors were computed for the purpose of obtaining norms for an adolescent group on the basis of the test in its standardized form and of comparing these results with those of Rorschach for adults.

Results

Table 3 presents the norms obtained with the adolescent group. For purposes of comparison, Rorschach's results for average adults are reproduced, with those of *Behn-Eschenburg* (1), *Löpfe* (8), and *Loosli-Usteri* (7) since their respective groups corresponded in age to the present group. Behn-Eschenburg's group ranged from thirteen to fifteen years which corresponds to the middle of our group. Both the other groups appear to be younger than the present experimental group. In comparing these norms, it must be kept in mind that the technique of administration and of scoring varied with the investigator and that the composition of the groups likewise differed to a great extent.

Total number of responses (R). The Patrick Henry group averaged 27.05 R, Standard Deviation 8.85, the approximate normal range being 18 to 36. Herein the approximate range is computed by taking one standard deviation above and below the average, thereby marking off the limits of the middle two-thirds of the distribution. This range corresponds to Rorschach's figures for adults. Loosli-Usteri reported a median of 23, the other two investigators, however, reported higher averages, 33.6 and 42 respectively.

Whole answer (W). In the Patrick Henry group, an average of 6.78 W was obtained, Standard Deviation 4.74. The approximate norms were considered 2–10. This range includes Rorschach's norms. This average is slightly higher than those reported by

Behn-Eschenburg (5.8) and Loosli-Usteri (5.) but considerably more than that of Löpfe (3.7).

Normal detail answer (*D*). Rorschach did not give norms for the normal details given by his average adults. In a subsequent article Rorschach indicated that for a score containing 34 responses in all, the following combination should be expected 8 W, 23 D, 2 Dr, 1 Ds and 0 Do. The average for the adolescent group was 14.08 Standard Deviation 6.55, giving a range of approximately 7 to 21. This compares favorably with the results of the other three investigators who obtained 18.4, 19.0, and 15 respectively.

Rare detail answers (*Dr*). The rare detail answers were studied from two different aspects (*a*) when the oligophrenic category was considered and (*b*) when this category was omitted. An average of 1.93 Standard Deviation 4.38 was obtained when the oligophrenic factor was considered. This figure corresponds to Rorschach's estimate on the basis of 34 responses. The range of about 0 to 6 is much shorter than the ranges presented by the other investigators. The average ap-

TABLE 3

Rorschach norms for different groups

	RORSCHACH	HERTZ	BEHN-ESCHENBURG	LÖPFE	LOOSLI-USTERI
Subject	?	300	209	120	63
Age	Adults	12.6–16.5	13–15	10–13	10–12
Test Factor					
R	15–30	27.05 (3.21)	33.6 (0–81)	42 (8–100)	23 (8–100)
W	4–7	6.78 (4.74)	5.8 (0–18)	3.7 (0–17)	5 (1–15)
D		14.08 (6.55)	18.4 (4–30)	19.0 (6–54)	15 (0–50)
Dr		1.93 (4.38)	7.1 (0–54)	13.5 (0–133)	2 (0–30)
Do		0.96 (1.70)	0.9 (0–10)	1.5	0 (0–3)
DS		1.73 (1.80)	1.0 (0–7)	2.3	1 (0–22)
%F+	70–80%	88.80% (3.09)	71 (55–100)	75% (23–100)	80% (43–100)
M	2–4	2.62 (3.71)	1.3 (0–5)	0.9 (0–9)	0 (0–6)
C Score	0.5–2.5	1.34 (1.51)	1.3	2.7	1 (0–20.5)
%A	30–55%	54.13% (10.77)	47% (15–90)	55% (20–100)	57% (27–100)
%O	0–20%	6.78% (8.53)		25%	
%P		25.55 (6.65)		11 (0–37)	21 (3–50)

proaches the median of Loosli-Usteri (2) but is much smaller than the averages of the other two investigators. Results for the Dr factor computed without scoring the Do factor (which was found to be more reliable), was 2.31 Standard Deviation 3.6.

Oligophrenic detail answers (Do). The adolescent group studied gave an average of .96 Do Standard Deviation 1.7. As indicated above, Rorschach did not expect to find any Dos in the score on the basis of 34 responses. The other investigators referred to above report few or no Do responses in their respective groups. These results appear to be in agreement.

Space detail factor (DS). The average space detail answers given by the group was 1.73, Standard Deviation 1.8. Rorschach expected 1 DS to appear in 34 responses given by a normal adult. The other investigators likewise reported comparatively few DS responses in their respective groups of children.

Form percentage (%F+). Examination of Rorschach's norms for average adults shows a range of 70 to 80 per cent. The average for the Patrick Henry Group was 88.8 Standard Deviation 2.09 indicating a range much higher than that of Rorschach. These figures are likewise much higher than the results reported by the other investigators.

Movement answers (M). The Junior High School group had an average of 2.62 M, Standard Deviation 3.71. Rorschach's adults gave from 2 to 4 movement answers. The average here compares favorably with that of Rorschach but appears to be higher than the results of the other writers for the movement factor.

Sum color score (C). The average color score for the group was 1.34 Standard Deviation 1.51, the approximate norm being 0–2.8. This compares well with Rorschach's range of 0.5 to 2.5. The results of the other writers likewise approximate this norm.

Animal percentage (%A). The average obtained with the present group of 54.13 Standard Deviation 10.77 compares favorably with that reported by Rorschach and also with the figures in the other studies. The upper range of Rorschach's figures appear to be the average for children.

Original percentage (%O). The average original per cent of the adolescent group was 6.78 Standard Deviation 8.63. The approximate norm here (1–15 per cent) compares well with Rorschach's estimate of 0–20 per cent. Löpfe's average is 25 per cent, which is considerably higher than the average obtained in the present study.

Popular answer percentage (%P). An average of 25.55 per cent Standard Deviation 6.64 for the present group is considerably higher than the average of Löpfe which was 11 but compares better with Loosli-Usteri's figure of 21. This factor was not defined in the original work of Rorschach, but it was introduced in a later article (12) as a response given at least by one in three persons. Löpfe and Loosli-Usteri finding this standard too high, adopted the criterion of one in six. The criterion employed in the present study corresponded to the one-in-six. It was statistically computed and based on the 80th percentile in the distribution

for form frequency, the criterion for the 0+ per cent being based on the 20th percentile. Despite the fact that the same criterion for P is used, it must be noted that the popular responses for each blot reported in the different studies do not correspond in all instances.

SUMMARY

1. The approximate norm for many of the Rorschach factors obtained in the present study with an adolescent group of 300 students corresponds favorably with Rorschach's results for adults.

2. The results herein obtained likewise compare favorably with those contained in other studies with normal subjects for similar age groups.

3. The average whole answer reported for the group is slightly higher than that reported by the other investigators, while the average normal detail answer is slightly lower.

4. Present results for the oligophrenic detail answer and the space detail answer correspond favorably with all the other results.

5. The average percentage of good forms for the group studied is considerably higher than that reported for the other groups.

6. The average movement answer is likewise higher for the present group.

7. The average color score and the animal percentage compare favorably with the approximate figures reported by the other investigators.

8. The average original percentage for the present group approximates Rorschach's norms but is considerably lower than that of Löpfe.

9. Results for the popular answer factor correspond to those of the other investigators.

10. The average number of responses compares favorably with Rorschach's estimate. The normal range computed in the present study includes those results of the other writers.

Conclusion

The norms herein reported are based upon findings with 300 adolescent Junior High School students, American-born, residing in Cleveland, and satisfactorily distributed as to mental and chronological ages. They correspond in general to those reported by Rorschach for adults and to those published by three other investigators for similar age groups. The discrepancies which do occur in places probably can be accounted for by the fact that the present group is a high average group. These norms may be employed tentatively for the interpretation of Rorschach test scores given to similar age groups, in the absence of other norms and until further investigation is made with the test on larger and more representative groups.

Attempts to apply such norms to groups materially different from that herein described must be made with caution. Strictly speaking they are applicable only to similar groups similarly selected. However, in the absence of norms for other groups, these figures could be used, bearing in mind the composition of the original sample upon which they were based, and accepting only those results which show statistical reliability.

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An Adolescent Personality Schedule

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PROBLEM

ADOLESCENTS, as a rule, respond to the interview as a diagnostic and remedial technique more satisfactorily than any other age group. They have a mastery of verbal facility which the younger child lacks and they have not yet acquired the fixity of repressions and verbal defense mechanisms which impede the progress of the interview with an adult. Because of this initial advantage, interview technique, as it relates to adolescent problems, presents a field which will repay efforts toward further methodological development. The statistically controlled interview, exemplified by mental hygiene inventories and personality schedules is a timesaving and illuminating starting point for any interview if the schedule be well constructed. The Thurstone Personality Schedule for adults offers many advantages from the point of view of ease of presentation, economy of time used in answering and scoring and of statistical reliability. For this reason we used it as a model for a projected statistically controlled interview suitable for use with adolescents.

The work herein reported was conducted at The Wichita Child Research Laboratory between January, 1930 and May, 1934. We are deeply indebted to Dr. L. L. Thurstone for suggestions and guidance throughout the progress of the work and for permission to make a comparative study of our results with his; to Mr. L. W. Mayberry, Superintendent of the Wichita Public Schools, to Mr. J. E. Stinson, Principal of Allison Intermediate and to the teachers of Allison Intermediate for the generous gift of their interest and time in assisting us to present the questions to the student population of the school; and to the many friends in different professions whose work brought them into contact with adolescents and who helped us with criticisms and suggestions when we were compiling our initial list of questions.

Method

In the compilation of the first list of questions we were guided somewhat by questions asked and remarks made by adolescents and recorded in the case histories of children who had been interviewed at the Wichita Child Research Laboratory. This source of suggestion was supplemented by the observations of the authors, all of whom had had intimate experience with adolescents and one of whom (Mrs. M. C. McClellan) was at that time the public school teacher in the Girls' Detention Home for Sedgwick County. Questions were also furnished by teachers, by social workers and by workers in summer camps for boys and girls of adolescent age. Some questions were suggested by those found in adult personality inventories and schedules.

The completed list of questions was

then submitted to a number of teachers in both private and public schools; to directors and workers in summer camps; and to ministers, psychologists and social workers. These were asked to rate the questions in what seemed to them to be the order of importance for inclusion in a final list. In making this rating they were asked to consider the importance for personality development of the subject matter of the question; the degree of illumination the answer might shed on potential personality difficulties of adolescents; and the chances of getting from the adolescent an answer based on a reliable comprehension of the meaning of the question as related to his own experience. Those, who were asked to rate the questions, were also asked to suggest new questions of their own and to include these in their rating lists.

A study of all the rated lists showed a surprising degree of uniformity among them as to the judgment of relative importance of the questions. We selected the questions which showed a high frequency of favorable rating and compiled a list of three hundred and thirty.

The questions were printed in double columns in a four paged leaflet. A "Yes," a "No" and a question mark were at the side of each question in an arrangement which permitted answering by means of circling the appropriate response in the manner used by Thurstone. The distribution of the responses was varied eccentrically to avoid any halo effect as an influence on the replies.

Arrangements were made with the school authorities to present this questionnaire to the entire school population of one of the large intermediate schools. All the children took the test simultaneously. An hour was given to the test and each class was working in its home room under the home room teacher. The children were given to understand that the test was part of the regular school program and encouraged to answer readily and as truthfully as possible. No discussion of the questions was allowed among the children or between the children and teacher but the teacher was allowed to explain the meaning of words which were unfamiliar. Each pupil wrote at the top of his sheet his age, birthdate, sex and school grade but they were not asked to write their names. The fact that there was no possible means of identification of the papers after they had left their hands was emphasized because we hoped the children might make their answers more spontaneously and honestly if they were sure the replies were to remain genuinely anonymous for all time. The fact that only three papers showed obvious lack of discrimination in the replies indicated that our hope was justified.

The school chosen represented a group of children fairly homogeneous in scholarship and social background. The residential district surrounding this school is neither the wealthiest nor the poorest in the city. It is populated chiefly by middle class families who are economically secure but not living in any pretentious style. The cultural background is average and on the whole produces students who make consistently successful but not brilliant records of academic achievement. It seemed to us this school presented an ideal situation from the point of view

of securing a large number of children from a uniformly average environmental background.

Six hundred and forty-eight children took the test. Three hundred and twenty-two of them were boys and three hundred and eleven of them were girls. Inevitably some of the children did not clearly understand all of their instructions and some of the information as to sex, age, etc. failed to appear on a few of the papers. This partial failure to fulfill instructions invalidated these papers for part of the statistical work but not for all of it. Therefore some of the statistical figures will vary as to the number of cases upon which they are based. Fifteen papers were not finished within the hour allowed for the test. On nearly every paper there were at least two or three questions that were unanswered. This was probably due to the fact that the questions were printed closely together and one could easily be overlooked. The same confusion of printing probably explains the fact that occasionally a question was answered twice.

Our first analysis of the results led to the elimination of some of the questions. The detailed method by which this elimination was reached will be presented with the results. When this elimination process was finished the results of the remaining questions were subjected to the procedure and technique used by Thurstone (1) in developing his personality schedule for college students.

RESULTS

A. *Elimination technique*

All of the papers were divided into two groups according to sex. The number of "Yesses," "Noes," "?," and "Unanswered" replies were tabulated for each group and the total for the entire group calculated. When this tabulation was completed twelve questions were eliminated, because they had been answered with 90 per cent uniformity either as "Yes" or "No."

The entire group of remaining questions was classified according to the following headings:

1. Fears
2. Inferiorities and insecurity
3. Family situations involving non-authoritative emotional relationships
4. Family situations involving authoritative relationships
5. Non-family authoritative situations involving emotional reactions
6. Opportunities for personal responsibilities in home situations, in school situations and in social relations with other children and reactions to these opportunities
7. Ambitions
8. Frustrations
9. Escapes
10. Neurotic symptoms
11. Compensatory devices

In carrying the elimination program further these headings were borne in mind. We felt that the final list of questions must represent a division into these groups which would not be overbalanced in favor of any one group. Part of the questions were discarded which the first tabulation showed had been answered predominantly in either the affirmative or negative. Others which showed this predominance in favor of one or the other were retained if there were some reason which made their retention advisable such as qualitative value of the question for diagno-

sis or need to include the question to help maintain balance among the classification groups. In some instances the phraseology of the questions seemed to have been confusing and these were discarded. Finally all questions with duplicated content were discarded. We found there were very few questions left in groups seven and eight. We, therefore, put into other groups such questions as remained in groups seven and eight after the foregoing elimination process.

Two hundred and eleven questions survived the discard, and were distributed among the classification headings as follows:

1. Fears........................... 21
2. Inferiorities and insecurity..... 27
3. Family situations involving non-authoritative emotional relationships..................... 30
4. Family situations involving authoritative relationships....... 16
5. Non-family authoritative situations involving emotional reactions........................ 15
6. Opportunities for personal responsibilities in home situations, in school situations, and in social relations with other children, and reactions to these opportunities........... 29
9. Escapes......................... 18
10. Neurotic symptoms............. 35
11. Compensatory devices.......... 20

This final revised list of two hundred and eleven questions was then subjected to a statistical scoring and rating program.

B. Scoring and rating

Empirical maladjusted answers were determined upon for the two hundred and eleven questions which comprised the revised list. The empirical answers were justified by statistical evidence for 195 questions. For these questions the maladjusted answers were numerically the fewest. Most of the fifteen questions whose empirical maladjusted answers were not statistically justified disappeared from the list in later statistical elimination.

Stencils were made for the maladjusted answers and all the papers were scored. The score for each paper was arrived at by counting the maladjusted answers. The fifty papers showing the highest scores and the fifty papers showing the lowest scores were segregated. For each of these groups of fifty, the number of maladjusted answers was tabulated for each question. As a result of this tabulation, ten questions were eliminated because the scores in the two groups were so nearly equal that the questions were judged to have little diagnostic value.

The group having the lowest number of maladjusted answers was found to have the larger number of maladjusted answers in the case of eight questions. The maladjusted answers for these eight questions were therefore reversed. For instance, the empirical maladjusted answer was "No" to the question, "Are mystery stories good reading?" The results for this question as answered by Group "A" (the group with the largest number of maladjusted answers) were:

16 answered "No"
34 answered "Yes"

Group "B" (the group having the lowest *number of maladjusted* answers) answered as follows:

25 answered "No"
25 answered "Yes"

This would indicate that for adolescents the maladjusted answer to this question is "Yes."

New stencils were made on the basis of these findings and the papers were rescored. The following table (table 1) shows the frequency distribution for the entire group and for boys and girls separately. It also presents a comparison with similar results for the Thurstone schedule (1929 edition of the Thurstone Personality Schedule).

TABLE 1

Frequency table

MALADJUSTMENT SCORE	BOYS	GIRLS	TOTAL	TOTAL (THURSTONE)*
0–4	0	0	0	15
5–9	1	0	1	37
10–14	3	2	5	57
15–19	5	8	13	65
20–24	18	9	28	67
25–29	24	14	39	66
30–34	38	18	57	50
35–39	25	23	51	64
40–44	22	30	62	37
45–49	27	27	54	60
50–54	23	33	57	44
55–59	27	20	57	24
60–64	27	22	50	18
65–69	30	20	51	22
70–74	16	15	31	17
75–79	12	10	29	10
80–84	9	9	19	10
85–89	6	6	13	0
90–94	1	7	9	2
95–99	5	4	9	7
100–104	1	5	6	1
105–109	1	0	1	1
110–114	0	1	1	2
115–119	1	0	1	
120–124	0	4	4	
Total...	322	311	648	682

*1929 edition of Thurstone personality schedule.

Median scores for sex and age differences were established as follows:

	MEDIAN SCORE	NUMBER OF CASES
Boys	53	322
Girls	52	311
Both sexes combined	51	648

In establishing the median for both sexes combined we included the fifteen papers which did not state sex, which explains the fact that the median for both sexes is lower than that for either the boys or girls separately. There is no significant sex difference. Median scores for school placement are as follows:

	MEDIAN SCORE	NUMBER OF CASES
7th grade	50	101
8th grade	50	237
9th grade	51	103

There is no significant school placement difference. Median scores for age follow:

	MEDIAN SCORE	NUMBER OF CASES
12 years	47	70
13 years	52	105
14 years	49	203
15 years	53	125
16 years	48	20

The group included students who were 11, 17, 18 and 19 years old but their number was too small to justify the calculation of medians. We do not find significant differences within the age groups for which the medians were calculated.

Thurstone assigns meaning to the maladjusted answer scores as follows:

PERCENTAGE OF CASES	MALADJUSTED ANSWERS	GRADE	MEANING
15	0–14	A	Extremely well adjusted
30	15–29	B	Well adjusted
40	30–59	C	Average
10	60–79	D	Poorly adjusted
5	Over 80	E	Should see a psychiatrist

1929 edition of Thurstone personality schedule.

Applying this interpretation to our own frequency table (table 1) we obtain the following rating for the adolescent schedule:

PERCENTAGE OF CASES	MALADJUSTED ANSWERS	GRADE	MEANING
15	0–29	A	Extremely well adjusted
30	30–49	B	Well adjusted
40	50–74	C	Average
10	75–89	D	Poorly adjusted
5	Over 90	E	Should see a psychiatrist

The questions on our leaflet were printed in two parallel columns on each page as on the Thurstone blanks. We measured the reliability of this test by counting the number of maladjustments in the four left hand columns and the number of maladjustments in the four right hand columns. These two sets of scores were correlated by the Pearson product moment method. The correlation was .79 $\pm$.01. When the Spearman "prophecy" formula was applied to this correlation the reliability coefficient was found to be .84. These results are consistent with those of Thurstone.

The final set of questions comprising the Adolescent Personality Schedule follows:

1. Yes ? I like to be alone most of the time.................................... No
2. No ? Are books better friends than people?.................................. Yes
3. Yes ? I want to get away from home right away.............................. No
4. No ? I am afraid to go into a dark room alone at night...................... Yes
5. No ? I like to work with my mother... Yes
6. No ? I fuss with my brothers and sisters whenever I am with them........... Yes
7. Yes ? Do you spend time daydreaming when you should be working?........... No
8. Yes ? I cry when I get angry... No
9. No ? I am afraid to talk to people... Yes
10. Yes ? Do you ever go off by yourself and talk about your troubles?........ No
11. No ? I like to entertain my friends at home............................... Yes
12. No ? Does fire or the smell of smoke make you afraid?..................... Yes
13. Yes ? I got a lot of whippings.. No
14. No ? Do you cry easily?... Yes
15. No ? Do you ever have a feeling of falling just before you go to sleep?.... Yes

16. Yes ? Do you ever feel that your parents do not love you?.................... No
17. Yes ? My family embarrass me terribly.. No
18. No ? Is it fun to make things sound bigger than they really are?............. Yes
19. Yes ? Do you sometimes like to hurt a person or animal?...................... No
20. No ? I have definite plans about what I want to do after I am through school... Yes
21. Yes ? Do you have the same dream over?.. No
22. No ? Are you usually to blame for your mistakes?............................ Yes
23. Yes ? I chew on something most of the time, pencils, erasers, etc.............. No
24. Yes ? Do you often leave work unfinished?...................................... No
25. Yes ? I am afraid that I will be talked about.................................. No
26. No ? Can you persuade other boys and girls to do things?..................... Yes
27. Yes ? Do you like to have the opposite sex at your parties..................... No
28. No ? Do you feel like fighting when someone gets the best of you in a game? Yes
29. No ? Do you like to talk about your troubles?................................ Yes
30. Yes ? Have you ever been told that you couldn't be good?...................... No
31. No ? Do your brothers and sisters do things better than you can?............ Yes
32. Yes ? Can usually control your temper?.. No
33. No ? Do you worry over your mistakes?...................................... Yes
34. Yes ? Is your mother happy?... No
35. No ? Have you ever been told that you were stupid?.......................... Yes
36. Yes ? Do mothers have all the work and no fun?................................ No
37. No ? My parents treat me like a baby.. Yes
38. No ? I have been teased a lot... Yes
39. Yes ? It is fun to tease little children...................................... No
40. Yes ? I can think of good answers in class but I am afraid to tell them........ No
41. Yes ? Does your mother still consider you a baby?............................. No
42. No ? Have you ever been told you couldn't tell the truth?................... Yes
43. No ? Can you play games as much as most boys and girls?..................... Yes
44. Yes ? Do you feel that you are a very wicked person?.......................... No
45. Yes ? Does nagging make you want to do things you know are wrong?........ No
46. Yes ? Do any of your brothers and sisters envy you?........................... No
47. No ? My hands and feet feel too big for the rest of me....................... Yes
48. Yes ? Do you often feel there is just no use to try?........................... No
49. Yes ? I seem to act just the opposite from what I feel......................... No
50. Yes ? Do you like to be with people you can boss?............................. No
51. Yes ? Do you have a hard time going to sleep after you go to bed?............ No
52. No ? Are you different from others in appearance?........................... Yes
53. No ? Mother and father are partial to other children in our family........... Yes
54. Yes ? Do your parents ever tell you that you are good for nothing?........... No
55. No ? Do you have a hard time making up your mind about things?............ Yes
56. Yes ? Do you feel glad one minute and sad the next without any apparent reason? No
57. Yes ? I am my father's pet.. No
58. Yes ? Are you made fun of at home?.. No
59. No ? Do married people always quarrel?..................................... Yes

60. No ? Do your parents find fault with you a great deal? .... Yes
61. Yes ? Do you feel sort of tired a great deal of the time? .... No
62. No ? Do you often vomit? .... Yes
63. Yes ? My parents are fair .... No
64. Yes ? Do you love your mother more than you do your father? .... No
65. No ? Do you often cry yourself to sleep? .... Yes
66. Yes ? Do you blush easily? .... No
67. No ? I earn my own spending money .... Yes
68. No ? Do you think you have a happy home? .... Yes
69. No ? Do you mind going through tunnels? .... Yes
70. No ? Do you feel free to talk to your parents about everything? .... Yes
71. Yes ? Do you have stage fright? .... No
72. Yes ? Do you have regular home duties? .... No
73. Yes ? Do you dream about your school work? .... No
74. No ? Do you like most everything to eat? .... Yes
75. Yes ? Do you have a habit of reading a long time after you go to bed? .... No
76. No ? Are you afraid of furred or feathered animals? .... Yes
77. Yes ? Are you afraid of being left behind on pleasure trips? .... No
78. No ? I find my school work burdensome .... Yes
79. Yes ? Are you afraid of deep water? .... No
80. No ? It worries me when I can't believe what my parents or the ministers say about religion .... Yes
81. Yes ? Do you fidget a great deal? .... No
82. Yes ? I am always scared that I will do the wrong thing .... No
83. No ? Do you sometimes feel like doing just anything to get people to notice you? Yes
84. No ? My feelings are easily hurt .... Yes
85. Yes ? Do you often feel stupid? .... No
86. Yes ? Do you think that little kids are a nuisance? .... No
87. No ? Would you be afraid to go to the principal's office? .... Yes
88. Yes ? Do you expect to get even with someone someday? .... No
89. No ? Can you always find a good reason for losing? .... Yes
90. Yes ? Do you feel like running away when things get too hard? .... No
91. Yes ? Do you feel you are a lot different than other boys and girls? .... No
92. No ? I hate to meet new kids .... Yes
93. Yes ? When my feelings are hurt it is easier to keep it to myself than let anyone know .... No
94. Yes ? I have a lot of friends .... No
95. Yes ? Do you mind crossing a bridge over deep water? .... No
96. Yes ? Are you ever afraid that folks will laugh at you? .... No
97. No ? Do you have a chum? .... Yes
98. Yes ? Can you stand pain quietly? .... No
99. Yes ? Are you afraid of being kidnapped? .... No
100. Yes ? Do you mind asking questions when you do not feel sure? .... No
101. Yes ? Do you ever feel mean and like you hate everybody? .... No

102. No ? Are you afraid to be out alone after dark? Yes
103. No ? Does it make you uneasy to cross a wide street? Yes
104. Yes ? Are you usually able to find your belongings when you want them? No
105. No ? Do you like help with your work? Yes
106. Yes ? Do you like to join and help organize gangs? No
107. Yes ? Is it often hard to resist setting fire to something? No
108. Yes ? Is it better to listen to your friends than to your conscience? No
109. No ? I won't be nice to people if they aren't nice to me first. Yes
110. No ? My clothes never feel right. Yes
111. No ? I hate things that are good for me. Yes
112. No ? Do you feel sorry for many of your friends? Yes
113. Yes ? Is it difficult to plan your work ahead? No
114. Yes ? Do you stick to the gang regardless? No
115. No ? Is your school principal a flop? Yes
116. No ? I was always whipped for every little wrong I did. Yes
117. No ? My relatives dislike me. Yes
118. Yes ? I quarrel a lot with my parents to get to go some places. No
119. No ? Do you go out for teams at school? Yes
120. No ? Must a school teacher be a very smart person? Yes
121. Yes ? Do you like to study about your body? No
122. No ? Older people do as they please. Yes
123. Yes ? Most mothers and fathers are terribly old fashioned. No
124. Yes ? I have awfully scary dreams. No
125. No ? I like to fight. Yes
126. No ? I like to read the "True Story" magazine. Yes
127. No ? I have been teacher's pet. Yes
128. Yes ? Modern young people know more than their parents. No
129. No ? I have never been able to work very much. Yes
130. Yes ? I have been badly hurt in an accident. No
131. No ? It is dangerous for a girl to let a boy kiss her. Yes
132. Yes ? I choose my own clothes. No
133. Yes ? School teachers are usually cross and narrow minded. No
134. Yes ? Big brothers and sisters are bossy. No
135. No ? Mystery stories are good reading. Yes
136. Yes ? Are Sunday School teachers queer? No
137. Yes ? It is better to be careful than to be adventurous. No
138. No ? Do you know many queer people? Yes
139. Yes ? Did your parents ever whip you when you did not deserve it? No
140. Yes ? Are you the favorite child in your home? No
141. No ? Are your parents more strict than other parents? Yes
142. Yes ? My teachers are always bawling me out about little things. No
143. No ? I kick my bed covers around something terrible. Yes
144. No ? I "feel" people following me when I walk alone at night. Yes
145. Yes ? People look strangely at me. No

146. Yes ? I would rather die than be where I am ... No
147. Yes ? Are you permitted to have pets? ... No
148. No ? My dad takes me places ... Yes
149. Yes ? I have been told a lot of bad things by other people ... No
150. Yes ? I am afraid of some of my relations ... No
151. No ? Does your father worry about money? ... Yes
152. Yes ? I would like to get married right away ... No
153. No ? Older people are always laughing at me ... Yes
154. No ? Is anyone at home willing to help you with your school work? ... Yes
155. No ? Do you have to be quiet when your father is at home? ... Yes
156. No ? Do you think your father should be more generous with his money ... Yes
157. No ? My mother and father have answered truthfully all of my questions if they knew the answer ... Yes
158. No ? It is fun to fool people ... Yes
159. No ? Do you ever worry about jails? ... Yes
160. No ? Do you ever worry about the world coming to an end? ... Yes
161. No ? It seems hard to stand up straight ... Yes
162. No ? My father and mother like one another ... Yes
163. Yes ? I don't know any decent boys or girls ... No
164. Yes ? I feel terribly strange when I give an oral theme ... No
165. No ? It is easy to get by parents now ... Yes
166. No ? Do you like to talk to your school teacher ... Yes
167. No ? Do you fear being up high and looking down? ... Yes
168. Yes ? Are you afraid when you are blindfolded? ... No
169. Yes ? I have done wrong to make other people like me ... No
170. Yes ? People have told me "scary" things ... No
171. No ? It is terribly hard to "go straight" ... Yes
172. Yes ? Do you fear meeting hold up men? ... No
173. No ? Are policemen watching their chance to get something on a boy or girl? ... Yes
174. Yes ? Did you ever have the habit of stuttering? ... No
175. Yes ? Do you think you are more nervous than most boys and girls? ... No
176. Yes ? Do you get started laughing and are unable to stop? ... No
177. Yes ? Have you ever had a vision? ... No
178. Yes ? Do you get all nervous when you see an accident? ... No
179. No ? Do you worry about going to hell? ... Yes
180. No ? Do you ever feel left out of things? ... Yes
181. Yes ? Do you enjoy most of the things that your friends enjoy? ... No
182. Yes ? Do you have to watch most people or they will cheat you? ... No
183. Yes ? Do you mind having your friends see you working? ... No
184. Yes ? Is there anything you do better than anyone else? ... No
185. Yes ? Do you ever have any luck selling anything? ... No
186. No ? Do you think you will accomplish as much as your parents have? ... Yes
187. No ? All fathers are good for is to earn money ... Yes
188. Yes ? It is easy for me to get by in school ... No

189. Yes ? I believe that most people are real good.................................. No
190. No ? If I work very hard my back bothers me................................ Yes
191. No ? I used to be afraid of my father.. Yes
192. No ? Kids have made fun of me.. Yes
193. No ? Do you sometimes like to pretend that you are somebody else?......... Yes
194. No ? Does saying your prayers at night make you feel better?................ Yes
195. No ? Do you make up stories about yourself helping other people out of trouble? Yes
196. Yes ? Do you ever day dream about being adopted by a rich family?............ No
197. Yes ? Mothers know more than fathers.. No
198. No ? Do you break and tear and spoil things more than most boys (girls) do?.. Yes
199. No ? Does your heart ever pound in your ears?.................................. Yes
200. Yes ? Do you ever feel as if you were smothering?................................ No
201. Yes ? Can you find your way about in the dark with very little trouble?...... No

The maladjusted answers are underlined.

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Brief Reports

A Note on the Relative Development-Age Scores of Urban and Rural Boys

A RECENT study by Merwick (1) investigated the influence on Developmental Age of five social factors, namely, socio-economic status, residence in a child-caring institution, urban life, residence in a particular part of the country, and position in the family. Of the five, urban life stood out most prominently. The present paper represents an attempt to analyze more fully this factor of urban, as against rural, environment, to determine what tests in the scale account for the higher average scores of urban boys and to suggest, if possible, the reasons underlying these higher scores.

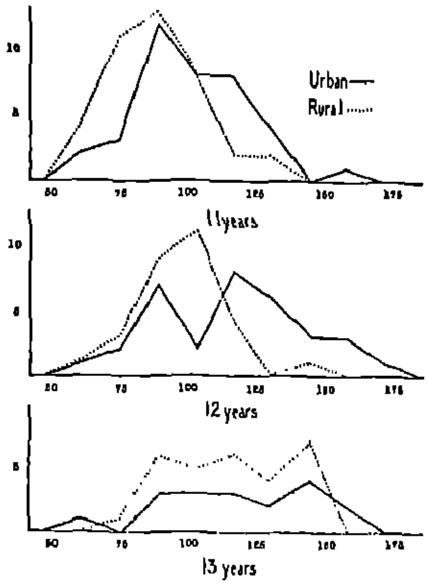
The subjects were 187 boys, aged eleven to thirteen years. All were from the same section of the country, namely, the West North Central area. All were white children living in their own homes. The factor of age was controlled by instituting comparisons separately at the eleven, twelve, and thirteen-year age levels. Socio-economic status, mental age, position in the family, and number of siblings were not controlled, since previous studies have failed to show that these factors are significantly related to Developmental Age.

The accompanying figure 1 shows that the precocity of the urban boys exists at all three ages, although it is less striking in the case of the 13-year-olds. It is interesting to ask whether this superiority is present in all the six tests of the scale or is confined to some of them. Table 1 compares the mean scores on the six tests at the three ages. As will be seen, the rural boys are ahead in only two of the eighteen comparisons. The conventional procedure at this point would be to compare the obtained differences to their standard errors; but to the present writer this seems a pointless procedure when we do not know that the variable in question is normally distributed.

Table 2 shows essentially the same comparison, but in slightly different form. Here the percentages of urban boys exceeding the median score of the rural group are tabled. As will be seen, the percentages only twice drop below fifty per cent and are equal to that figure in one other case.

An examination of these tables shows that the urban precocity is not confined to any one of the six tests, but is fairly evenly distributed over five of them. Test 6, which deals with "things to think about," is the only test which fails to show the characteristic urban precocity. The writer can suggest no reason why Test 6 should differ in this respect from the other tests. Probably it is to be

explained as a sampling phenomenon. It has often been said that city boys act more maturely than country boys of the same age. The data reported in the present paper afford an objective confirmation of this popular belief; for they show a precocity equivalent to about a year and one-third at age



Distribution of Total DA Score of Urban and Rural Boys at Specified Ages

FIG. 1

TABLE 1

Comparison of means of rural and urban groups on the separate tests

GROUP	TESTS						
	1	2	3	4	5	6	Total
11-year urban	26.3	12.0	12.2	21.5	13.8	14.2	100.0
11-year rural	21.0	10.1	10.0	18.9	13.2	13.6	86.8
Difference*	5.3	1.9	2.2	2.6	0.6	0.6	13.2
12-year urban	30.6	14.5	14.3	26.1	15.5	16.1	117.1
12-year rural	25.6	11.0	10.9	20.8	13.6	15.3	97.2
Difference	5.0	3.5	3.4	5.3	1.9	0.8	19.9
13-year urban	31.0	13.5	15.2	26.0	15.7	17.0	118.4
13-year rural	32.0	11.3	14.0	23.3	15.5	18.0	114.1
Difference	−1.0	2.2	1.2	2.7	0.2	−1.0	4.3

* Urban minus rural.

eleven, about two years at twelve, and about one-third of a year at thirteen.

TABLE 2

Percentage of urban boys exceeding median D. A. of rural boys

AGE	TESTS						
	1	2	3	4	5	6	Total
11	63	68	68	55	58	58	77
12	73	70	70	73	73	61	70
13	44	67	61	56	50	39	56

Possibly these differences are large enough to be taken into account by those who plan practical work with boys. If this is true, then we should not try to fit urban and rural boys into the same mould. Recreational programs should not be taken over bodily from the city and applied to country boys without making due allowance for urban precocity. Books written for parents should take account of these rural-urban differences. Our present knowledge of the child is based on data gathered within a rather restricted range of social conditions. Perhaps, in the future, we ought to become more conscious of the possible effects of differential environments.

PAUL HANLY FURFEY.

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A Study of Some Factors Entering into the Determination of Handedness

Mary M. Roos

THE essential nature of this study is that of a fact finding investigation of some theories of causes of handedness and of alleged relationships within the infant groups.

In another paper not yet published, I made a purely statistical analysis and interpretation of degrees of handedness in three age groups,—namely, kindergarten children, sixth grade children and college students. One conclusion reached there, which is pertinent to this study, is as follows:

> "In view of the results presented . . . . , it would seem practically certain that the handedness index of a group of infants, as measured by the tapping test or some other test of what might be called native handedness, would be distributed normally, that is, that log R/L would be distributed normally."

In other words, the statistical analysis and interpretation referred to above indicates that the frequency distribution of the symmetrical index of handedness, log R/L, where R is the count for the right hand and L is the count for the left hand for a similar type of performance, obeys the normal frequency law at birth. This conclusion indicates that there is no "single cause" for what might be called native right and left handedness. This does not mean, however, that the frequency curve of an adult group will follow the normal law, for when the test used is a test of acquired ability such as that given by a writing test or a number marking test, the frequency distribution obeys quite a general frequency law which in no sense of the word can be called normal. Hence, one must be careful to distinguish between the accompaniments of left handedness and the causes of it.

Literature abounds with theories of the "causes" of dextrality. Some appear, on the surface, to be quite plausible, for instance, the theory of M. van Biervliet (4). On the basis of a very limited sample, he contended that there exists a symmetry of strength of reaction for all sense organs on a given side, and that when dextrality is dominant, the reaction is about one ninth stronger on the right side, whereas when sinistrality is dominant, the reaction is about one ninth stronger on the left side. He announced that he had established this relation for muscular reaction, vision, audition and touch.

Then, there is the theory of G. M. Gould (2), who maintained that all purposive movements followed the sighting eye. However, he postulated the actuality of the "sighting eye, without experiment." T. L. Woo and Karl Pearson (5) using the data on 7,000 subjects collected by Francis

Galton recently have undisputedly shown that these two theories are not supported by facts.

Also, there are theories which maintain that brain sidedness has a determining effect on handedness (1). However, if left brainedness should be found to be associated with right handedness, it could then be postulated to be either the cause or the accompaniment of right handedness. If it is the cause, and if as is indicated by my study mentioned above, the index of handedness is distributed normally at birth, then degrees of left brainedness would have to be distributed normally, and we would not, therefore, have any greatly explanatory information regarding the cause of right handedness until we knew the cause of left brainedness.

Moss (3) made the observation that there was a parallelism between the percentage of right handedness and the percentage of a certain type of birth presentation. He pointed out that, as is well known, during the last three to six weeks before birth the position of the foetus becomes relatively fixed, and that, in head presentations, which make up the greater percentage of all deliveries, the left arm is pinned against the mother's bony parts and the right arm is free to move, or the right arm is impinged against the mother's bony parts and the left arm is free. He noted that the percentage of babies that have the presentation position in which the left arm is in a fixed position and the right arm free corresponds roughly with the percentage of right handedness found in adult life, and, consequently, that the percentage of babies that have the presentation position in which the right arm is in a fixed position and the left arm free, corresponds roughly with the percentage of left handedness found in adult life. In order to carefully investigate this observation he secured the kind and effective coöperation of Dr. H. W. Lawson, former professor and head of the Department of Obstetrics at George Washington University, and of Dr. Howard Kane, Professor of Obstetrics at George Washington University. I desire to express my appreciation and gratitude to Dr. Fred A. Moss for his helpful advice and guidance in this study. These men kept a detailed record of the position of the foetus during the last part of pregnancy—in most cases the records were especially detailed for the last three months of pregnancy—and, in addition, other material concerning those prenatal factors which might be supposed to be related to handedness.

A total of 486 cases were studied in an endeavor to ascertain the relation, if any of the presentation position of the foetus to dextrality and of other possibly related prenatal factors to dextrality. There were 330 cases in the Kane group, and 156 more in the Lawson group.

By means of a test which was objective in all its phases save one, namely, that each mother tested her own child, the 486 babies ranging in age from six months to two years were tested for handedness. It was found that 18.3 per cent were left handed, and 81.7 per cent were right handed. It is well to point out here that the subjective element in this test probably

favors the percentage for right handedness, inasmuch as there is a tendency for most people to consider left handedness as an undesirable trait, and hence, most mothers would be desirous of having their children test with right handed reactions if possible. It is also most important to point out that the test, as it was used by the mothers, does not measure degrees of handedness. However, the test was conceived in the anticipation that degrees of handedness should be measured through its application. It was only because there was so much irregularity in the reports as given by the mothers that it was impossible to plot a frequency curve from their results. Each mother used the test only long enough to prove to her satisfaction that her child was either right or left handed, failing to realize that a very important bit of data would have been gained could it have been ascertained just how much right handed and how much left handed her child really was. However, for the immediate purposes of this study the broad demarcations of the child's being either right or left handed are quite sufficient.

A description of the test used is as follows: Two government penny postal cards on the same sheet of cardboard were folded together. One card contained the following instructions on the side not used for the address of the mother:

"1. On each of four days offer your child ten times each day some object he desires.

"2. Hold the desired object directly in front of your child so that no preference can be given either hand.

"3. Record on the accompanying record card the number of times your child reaches with his right hand and the number of times with his left."

The other card contained the author's address on one side, and on the opposite, a record for 1 and 2 above and also the following questions:

"Are any of your child's relatives left-handed? ——.

"Approximately at what age did your child have the first tooth? ——."

Factors which might influence handedness both prenatally and postnatally were considered. Four prenatal factors possibly related to handedness were investigated, the first of which was the dominant position of the foetus before birth and the presentation position of the child at birth. The seemingly feasible theory which led to this investigation has been indicated above.

A concise picture of the results of this study of 486 cases is given in table 1.

It will be observed that 89.6 per cent of the 486 observations fall within the LOA and ROA groups and that 83.2 per cent of these cases in the LOA and ROA groups are right handed, and that of the total 486 observations, 81.7 per cent are right handed and 18.3 per cent are left handed. Furthermore, 81 per cent of the LOA group and 79 per cent of the ROA group are right handed in the 330 observations; and in the 156 observations, 85 per cent of the LOA and 90 per cent of ROA are right handed. The percentage of right handednesss is so nearly the same for both major birth positions that the results of this section of the study seem clearly to indicate that the dominant position of the child in the uterus of the mother, and the birth presentation position of the child are not causally related

to its dextrality. This result, however, is exactly what should be expected in view of the indicated normal frequency curve for the dextrality of infants mentioned at the beginning of this paper.

Since certain factors, such as birth weight, metabolic rate of the mother, etc., which are known to influence the movement of the infant in the uterus were not taken into account, further studies of these factors were made.

A study of the basal metabolism of the mother during pregnancy as related to the handedness of the infant was made to investigate the hypothesis that if the prenatal environment were a determinant in preferential dextrality, the child of a mother with a tendency toward hyperthyroidism might show a tendency toward ambidexterity, whereas the child of a mother with a tendency toward hypothyroidism might be inclined to be either definitely right handed or definitely left handed. The theory back of this hypothesis was that the child of the hyperthyroid mother might be inclined to move about a great deal, and thus to move its arms both more vigorously and more often than the child of the hypothyroid mother.

It was found that within the 156 basal metabolism observations, the average basal metabolism of the mothers of 6 ambidexterous children was −7.3, and of mothers of 25 left handed children was −5.8, and of mothers of 125 right handed children was −3.7. From these results it would seem that the basal metabolism of the mother and the handedness of her child are not related.

TABLE 1

A study of presentation position and handedness

	DELIVERY POSITION																							
	LOA			ROA			LSA			LSP			RSP			RSA			ROP			LOP		
Handedness	R	A	L	R	A	L	R	A	L	R	A	L	R	A	L	R	A	L	R	A	L	R	A	L
Number	157	5	32	86	3	20	7	0	2	4	0	1	4	0	1	2	0	0	4	0	2	0	0	0
Per cent of 330	81	3	16	79	3	16	78	0	22	80	0	20	80	0	20	100	0	0	67	0	33	0	0	0
Number	78	0	14	19	0	2	5	0	0	0	0	0	1	0	0	2	0	0	23	0	7	5	0	0
Per cent of 156	85	0	15	90	0	10	100	0	0	0	0	0	100	0	0	100	0	0	77	0	23	100	0	0

ROA is right occipito—anterior presentation; LOA is left occipito—anterior presentation; LSA is left sacrum—anterior presentation; LSP is left sacrum—posterior presentation; RSP is right sacrum—posterior presentation; RSA is right sacrum—anterior presentation; ROP is right occipito—posterior presentation; LOP is left occipito—posterior presentation.

Another prenatal factor to be investigated was that of birth weight. It was known that a big child would have a fixed position longer than a small one. This led to the hypothesis that smaller babies would have a greater tendency toward ambidexterity than larger ones. There were 145 cases in this study, of which 23 or 15.9 per cent were left handed and 122 or 84.1 per cent were right handed. No ambidextrous babies were reported.

Seven of the 23 left handed children had birth weights below the average of 3866 grams, that is, 30.4 per cent. Sixteen of the 23 left handed children had birth weights above the average, or that is 69.6 per cent. Seventy of the 122 right handed children had birth weights below the average, or, that is, 57.4 per cent. The number of right handed children above the average birth weight was found to be 52 or 42.6 per cent. This would indicate that there may be some relationship between low birth weight and type of dextrality, but it would seem that the 7 left handed cases below the average birth weight constitute too small a sample from which to draw conclusions regarding the 27.0 per cent difference between the percentage of left handed children below the average birth weight and the percentage of right handed children below the average birth weight. Further study of this hypothesis would, in the opinion of the author, lead to the conclusion that there is no relationship between birth weight and handedness. Table 2 presents the data concisely.

Heredity as a prenatal factor was also investigated. It was believed that if heredity were a determining factor in handedness, the percentage of right handed children with an entire right handed heredity should be large, and the percentage of children with a mixed heredity should in the number of cases studied in this investigation follow a rather definite trend as to the extent of right and left handedness. Attention is especially called to the term "mixed heredity." There were no cases of pure left handed heredity reported. It should also be pointed out that only data on the handedness of the subjects and their parents were available.

The existence of left handedness in the blood line was checked in 330 cases. Of these 330 subjects, 178 or 53.9 per cent were found to be right handed with right handed heredity; 86 or 26 per cent were right handed with left handedness in the blood line; 16 or 4.9 per cent were left handed with a right handed heredity, and 50 or 15.2 per cent were left handed with a left handed heredity. Finally, 194 or, that is, 58.8 per cent had an entirely right handed heredity reported, and 41.2 per cent had an heredity in which there was some left handedness reported. The entire group was found to contain 79.9 per cent right handed-

TABLE 2

A study of birth weight and handedness

NUMBER OF CASES		PERCENTAGES
23	L handed children in group	15.0
122	R handed children in group	84.1
7	L handed children below average birth weight	30.4
16	L handed children above average birth weight	69.6
70	R handed children below average birth weight	57.4
52	R handed children above average birth weight	42.6

ness and 20.1 per cent left handedness. It may be well to point out again at this juncture that a frequency curve for dextrality is impossible where the degrees of handedness are unknown.

The data on heredity must be taken to have indicative value only; since they were subjectively reported by individuals and were not objectively measured by a standardized dextrality test such as the tapping or grip test (5). However, for indicative purposes, this part of the study is worthwhile. Thus it is interesting to compare these results with those of that is 7.4 per cent, had an entire right handed heredity reported. It was found that 56.3 per cent of the entire group had a right handed heredity reported, and 43.7 per cent of the group had some left handedness in the blood line reported. Further, the entire group was found to contain 82.4 per cent right handedness and 17.6 per cent left handedness. Table 3 illustrates well the agreement of the two studies. It should be remembered in studying these data that the 137 cases are included in the 330 cases. A second separate study was made for

TABLE 3

A study of heredity and dextrality, 330 cases

SUBJECTS	RIGHT HEREDITY		LEFT HEREDITY		TOTALS
	number	*per cent*	*number*	*per cent*	*per cent*
Right handed	178	53.0	80	26.0	79.9
Left handed	16	4.9	50	15.2	20.1
Totals	194	58.8	136	41.2	100.0
Right handed	67	48.9	46	33.5	82.4
Left handed	10	7.4	14	10.2	17.6
Totals	77	56.3	60	43.7	100.0

the above mentioned study of the infants who were actually tested with the reaching test for forty trials. It was found in that total group of actually tested babies that 67 of the 137 were right handed babies, or that is 48.9 per cent, who came from a reported right handed blood line. Furthermore, 46 or 33.5 per cent of the right handed babies had left handedness reported in their family lines. Also, 14 left handed babies, or that is, 10.2 per cent had left handedness reported in their blood lines, and 10 left handed babies, or the 137 cases because they represent cases of actually tested infant handedness, and not merely reported infant handedness.

It is interesting to note that 50 or 36.8 per cent of the 136 cases who had left handedness reported in the blood line were left handed as contrasted with 16 or 8.2 per cent who were left handed of the 194 cases who were reported to be of an entirely right handed heredity. It would seem, therefore, that there may be an hereditary element involved here. On the other hand, studies of other groups

indicate that extensive, careful experiments are necessary before definite conclusions can be drawn.

On the basis of the results obtained in this infant study it would seem that it is safe to conclude that:

1. There is no causal relationship between the dominant position of the foetus, the birth position of the child and dextrality.

2. The basal metabolism of the pregnant mother does not affect the dextrality of her child.

3. The birth weight of the infant at the time of delivery is not a determining factor in its dextrality.

4. The hereditary factor as indicated by the reported heredity is probably a significant quantity and a really scientific, objective measurement of this factor should be made.

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The Order of Participation of Limbs in Responses to Tactual Stimulation of the Newborn Infant

LOUIS DELMAN[1]

INTRODUCTION

MANY previous investigators have maintained that the behavior of the newborn infant is unorganized, random and chaotic, although some fairly specific patterns of the order of simple reflexes, such as sneezing, plantar, palmar, sucking and swallowing responses are present at birth.

Irwin (5) conceives of the behavior of newborn infants as falling into two descriptive categories: specific movements and mass activity. A specific movement is defined as "a segmental activity which occurs at a rate slow enough that it can be discriminated by an observer." Mass activity "involves the entire organism and proceeds at a rate too rapid for analysis, and often with uninterrupted continuity." Specific movements involve a single bodily segment. Mass activity is organismic or non-segmental in character. Specificity of behavior patterns in later life is held to be derived by a process of differentiation from an original matrix of mass activity.

Pratt, Nelson and Sun (9) hold similar views on the nature of the neonate organism.

> "Its behavior is generalized, that is stimulation of almost any group of receptors by almost any kind of stimulus will lead to a response in almost any part of the organism. The reaction tends, however, to mainfest itself most strongly in that part of the organism which is stimulated, and from there spreads out with decreasing frequency and intensity to the other segments of the body."

A second and older type of theory holds that the newborn is primarily a system of reflexes, whose behavior consists in a variety of specific, simple reflexes as well as some complicated specific responses of a reflexive nature such as instincts and basic emotions. The infant develops according to this view by modification and conditioning of these reflexive patterns. Such a view with reference to the development of emotional behavior is held by Watson (11).

This study is essentially an effort to analyze responses of the newborn with a view to determining the exact manner of their organization. The

[1] The writer wishes to acknowledge his indebtedness to Dr. Wayne Dennis, under whose direction this investigation was performed. Infants were made available for study through the kindness and coöperation of Dr. L. T. Royster of the University of Virginia Hospital.

earlier studies, dependent as they were upon unaided directed observation, could not attempt a detailed analysis.

If one could, in some manner, study the neonate's activity at a diminished rate, the relations involved in the movements of the various limbs could be examined and one might be able to substitute exact measurements of relations for the gross descriptive terms which now prevail.

For this purpose, the method of motion picture analysis obviously suggests itself as the best available method of preserving the responses for repeated analyses at a decreased rate of activity.

One inquiry into the regularity of responses is to ask whether or not they begin in a regular manner. This specific phase of the problem is the subject of the present research. This study is limited to analysis of the beginning of multisegmental, complicated responses. The only previous characterization which I was able to find in the literature, concerning the initiation of the total bodily response was made by Sherman (10).

> "The initial response, in other words, occurs in the part stimulated and spreads to other parts of the body. But the spread of these movements occurs so quickly that unless closely observed, they will appear only as generalized activity of the entire body, especially of the arms and legs."

Procedure

Motion pictures were taken in the University Hospital with a Cine Kodak Model B. K. A. camera (focal lens reading—1.9). The speed of running was approximately sixteen exposures per second. The camera was set in motion immediately preceding application of the stimulus and was shut off sometime after the response had involved two limbs or after ten seconds without a response had elapsed.

The apparatus was the same as that previously used by Gilmer (4). A wooden camera holder, each of whose 4 legs fitted over a corner of the infant's steel crib, was provided with a pointer to indicate the center of the photographic field. Illumination was provided by throwing the rays of a double Kodalite (Model B), which contained two 500 w., 115 v. Mazda lamps, against the wall directly over the subject's crib. The Kodalite was directed toward the wall at an angle which allowed no light to reach the infant directly from the lamp.

The stimulus was a flip of the experimenter's index finger. This was done by placing the nail of the index finger against the palmar surface of the thumb and exerting sufficient pressure to force the thumb outward and release the index finger, which then struck the subject. This procedure resulted, obviously, in variation of the intensity of the stimuli. Such variation makes any consistency in results even more significant than it would be if obtained when the intensity were kept constant. As a further experiment it would be interesting to control and systematically vary the stimulus intensity. However, one may urge that a first study may legitimately be concerned with the effects of stimuli of a practical rather than of an ideal nature.

The stimuli were applied to 4 regions of the body, namely to the sole of a

foot and the palm of a hand on both left and right sides of the body. In some cases the palm of the hand could not be reached without moving the infant's arm. In such situations, the back of the hand or the wrist was stimulated. Foot and arm stimulations were applied alternately. Right and left sides of the body were stimulated alternately from day to day. For example; on March 2 stimulus #1 was applied to the left foot, #2 to the left hand, #3 to the left foot, etc. On the next day stimulus #1 was applied to the right foot, #2 to the right hand, #3 to the right foot, etc.

There were two experimental periods each day, beginning in every case about one hour after a nursing period and ending about seventy-five minutes later. (The infants were nursed at 2 A.M., 6 A.M., 10 A.M., 2 P.M., 6 P.M., and 10 P.M.) Most of the experimental periods were at 7 A.M. and 3 P.M. One hour after nursing was selected as the most likely time to find the infants asleep. All data used in this experiment were taken when the infants were asleep, the criteria of sleep being closure of the eyes and immobility.

Uncovering the baby, which was always done immediately after setting up the photographic apparatus and before stimulation was begun, always resulted in a response. In this case, as in all others, where there was previous movement, an interval of at least ten seconds of immobility was allowed to elapse before any further stimulus was applied.

Control pictures during which there was no experimental stimulation were taken at various intervals during each experimental period. These were taken under the same conditions as were the experimental pictures, the only difference being lack of the finger flip.

The experimenter, who was generally alone in the nursery during experimentation, performed all the tasks, operating the camera with the left hand, applying the stimuli with the right hand and taking notes between stimulations.

The pictures were later analyzed to determine the first and second limbs to enter into the response. These will be designated hereafter as the first, or initial response and the second response. The films were projected on a white cardboard screen by a Kodascope (Business Model) Projector, which was run by hand. In most cases, by turning the projector crank very slowly, it was possible to determine with assurance the order in which the various limbs entered into the response. In many cases, however, determination by this method was impossible. In these cases, markers were fastened to the screen, which showed a still picture of the infant at the moment of application of the stimulus. One edge of each of the markers was placed in contiguity with the outline of each limb concerning which there was uncertainty at the point at which the first component of movement was evident. The projector was then cranked, frame by frame, until one of the limbs was no longer contiguous with its mark. This method proved highly successful in obtaining temporal differences where they ex-

isted. If this method yielded no temporal difference, the limbs in question were said to have begun moving simultaneously. Absolute reaction times were not calculated for the reason that they are not essential to the problem and that calculating reaction time from motion pictures is subject to obvious inaccuracies.

A number of cases had to be omitted from the computations due to lack of response or to simultaneity of response. Since there was obtained in many cases a definite first response and no second response or a simultaneous second response of two or three limbs, the number of second responses in the tabulations is less than the number of first responses. These cases of lack of or simultaneity of response both in first and second responses and in second responses only, were too few to merit further study, although with a large number of such cases analysis might provide some interesting results.

Subjects. The subjects of this study were three negro infants. Negro subjects were chosen because of better provision for experimentation which exists in the negro, rather than the white, nursery of the University Hospital. Baby S, a healthy, normal, male infant was studied from the fourth through the eleventh day of life. A total of 146 pictures of this subject were taken. Seventeen were control pictures. Seventeen were omitted from the computations due to simultaneity of response or lack of response.

Baby M, a healthy, normally delivered, female infant was studied from the second through the twelfth day. A total of 335 pictures were taken. Fifty-four were control pictures and fifty-two were omitted due to simultaneity or lack of response.

Baby D was a female infant delivered by Caeserian section. She was less active than the other two subjects, consequently a greater percentage of her pictures showed no response. A total of 237 pictures were taken. Thirty-five were control pictures and 71 were omitted due to lack of or simultaneity of response.

RESULTS

Control Pictures. The control pictures show that very little movement occurs, under the conditions of this experiment, when the stimulus is not applied. Seventeen control pictures of Baby S were taken. Of these, 88 per cent showed no movement. Of the 54 control pictures of Baby M, 80 per cent showed no movement. Baby D's records show no movement in 88½ per cent of the control pictures, which were 35 in number. The movements which occurred during the control pictures were too few to merit further analysis.

Number of Responses Involving All Limbs. Seventy-seven per cent of the responses of Baby S, 73 per cent of Baby M's and 46 per cent of Baby D's responses (those which were used in the following results) involved all four limbs. It must be remembered in this connection, that the camera was stopped in some cases before movement had ceased so that, had the entire course of reaction been photographed, a still larger percentage of responses would have shown move-

ments of all the extremities. It is obvious then that the responses which are to be analyzed are, for the most part, multi-segmental reactions.

The Initial Response. (1) Relation to the Stimulated Limb. According to the quotation from Sherman (10), above cited, the generalized response to almost any type of intense stimulus is supposed to begin in the stimulated limb and then spread to the other limbs.

These data indicate that, on the average, the first response is more likely to occur in the stimulated member (in about one third of the cases) than in any other particular member. However, it occurs with greater frequency at some part other than the stimulated member.

The method of analysis was to characterize the limb which moved first with respect to its direction from the stimulated member. These characterizations were four, namely "Same," "Contralateral," "Diagonal" and "Homolateral." For example, when the right foot is stimulated, an initial movement of the right leg is called "Same;" of the left leg, "Contralateral;" of the left arm, "Diagonal;" of the right arm, "Homolateral." The results of this analysis are given in table 1.

TABLE 1

Percentage of each type of initial response
Reliability of individual differences

	FOOT STIMULATIONS					ARM STIMULATIONS					SUM OF FOOT AND ARM STIMULATIONS				
	Baby M	Baby S	Baby D	D/Sigma D	Sum of 3 Subjects	Baby M	Baby S	Baby D	D/Sigma D	Sum of 3 Subjects	Baby M	Baby S	Baby D	D/Sigma D	Sum of 3 Subjects
Numer of Cases..........	121	53	70		244	108	59	61		228	229	112	131		472
"Same"............	34%	30%	48%	1.9	37%	31%	41%	21%	2.4	31%	33%	36%	36%	0.6	35%
"Diagonal"........	25%	36%	9%	3.6	23%	30%	24%	36%	1.5	30%	27%	29%	21%	1.4	26%
"Contralateral"....	35%	10%	36%	2.0	30%	24%	23%	15%	1.5	21%	20%	21%	26%	1.7	25%
"Homolateral".....	8%	15%	7%	1.4	10%	15%	12%	28%	2.2	18%	11%	14%	17%	1.5	14%

Table 1, in which the data are arranged to show differences between subjects, indicates the percentages of initial responses of each of the four types; same as, contralateral to, diagonal to, or homolateral to the stimulated limb. The first, second and third columns show the percentages obtained in foot stimulations for babies M, S and D respectively. The fourth column represents the critical ratios of the largest differences between any two of the subjects in a given type of initial response. The fifth column represents combination of the corresponding data for all three subjects. The other columns represent, as indicated, the corresponding data for arm stimulations and for combination of both foot and arm stimulations.

The reliabilities of the differences between the percentages for foot and for arm stimuli in the same individual are next considered. This comparison

is shown in table 2, which consists in a rearrangement of the same data as in table 1 for purposes of comparing the results of foot and arm stimuli rather than the results of different subjects for one type of stimulus. The differences are quite low in reliability for two of the subjects and highly reliable for the third. When the data for all three subjects are combined, the differences become smaller and of little reliability.

initial response to the stimulated limb: The initial response occurs in the stimulated member in about one third, the diagonal limb in one fourth, the contralateral limb in one fourth and the homolateral limb in one sixth of the cases. Individual differences are very frequent and sometimes very large. In many cases these individual differences would obscure relationships if the responses of all subjects were added together without considering the subjects separately. This is due to a frequently occurring compensatory relation between subjects. It is urged that the importance of determining the behavior organization of the *individual* be not overlooked by those who may undertake studies upon a larger number of infants. While the present study does not determine how *common* are the facts which were found, it may be indicated that the application of fewer stimulations per subject to a larger number of infants would not have shown how the behavior of *any* infant was organized.

TABLE 2

Percentage of each type of initial response
Reliability of differences between foot and arm stimulation

	BABY M			BABY S			BABY D			SUM OF 3 SUBJECTS		
	Foot Stimulations	Arm Stimulations	$\frac{D}{\text{Sigma D}}$	Foot Stimulations	Arm Stimulations	$\frac{D}{\text{Sigma D}}$	Foot Stimulations	Arm Stimulations	$\frac{D}{\text{Sigma D}}$	Foot Stimulations	Arm Stimulations	$\frac{D}{\text{Sigma D}}$
Number of Cases...........	121	108		53	59		70	61		244	228	
"Same"..............	34%	31%	0.5	30%	41%	1.2	48%	21%	3.4	37%	31%	1.4
"Diagonal"..........	25%	30%	0.9	36%	24%	1.4	9%	36%	3.8	23%	30%	1.7
"Contralateral".....	35%	24%	1.8	19%	23%	0.5	36%	15%	3.0	30%	21%	2.25
"Homolateral".......	8%	15%	2.2	15%	12%	0.5	7%	28%	3.3	10%	18%	2.5

Table 3 shows the reliability of the differences $\frac{D}{(\text{Sigma D})}$ between the different types of initial response. The percentages used are those in the extreme right hand column of table 1 which represents the percentages of the total number of initial responses to both types of stimuli of all three subjects. The critical ratios show that all the differences are reliable except that between "Diagonal" and "Contralateral" which is only 1 per cent.

Having examined the differences, we can make the following general statement regarding the relation of the

(2) Laterality. One aspect of be-

havior which has been frequently investigated is laterality, by which is generally meant any difference in functioning between the two sides of the body. A number of theories have been postulated to explain laterality differences. There are theories which account for handedness on the physical basis of cortical or other anatomical asymmetry. An example of such a hypothesis is that of Jordan (6), who holds that handedness is determined by *cerebral asymmetry, which in turn* is due to differential blood supply to

TABLE 3

Reliability of differences between each type of initial response—combined data for three subjects

	SAME	DIAGONAL	CONTRALATERAL	HEMOLATERAL
"Same"............				
"Diagonal".........	3.1			
"Contralateral"....	3.4	0.3		
"Homolateral".....	7.8	4.8	4.4	

the cerebral hemispheres during fetal life. On the other hand, there are empiricists who maintain that laterality is due entirely to training and social influence. Both of these schools of thought seem either to imply or definitely state that laterality is a general phenomenon in individuals, *i.e.*, is the same for all acts and situations. An obvious alternative, which seems to have been appreciated extremely rarely *in the literature, is that* laterality is specific to the different types of behavior. This would imply probably, though not necessarily, an empiristic rather than a nativistic view of the origin of laterality.

If laterality is at all native, it is most reasonable to believe that the expression of its native component is general for all types of laterality. If there is ever a generalized laterality it would seem that the newborn infant is the most likely individual to exhibit it. Thus any laterality in first responses exhibited by the subjects of this experiment, would represent a contribution *to the complete analysis of behavior* of the newborn with respect to the problem of generality or specificity of lateral dominance.

Table 4 shows for all 3 subjects the percentage of initial responses which were on the right side (*i.e.*—right leg or right arm) and on the left side. The calculations are given separately for stimulations of the left side and the right side, then all stimulations combined. The reliability of each difference between percentages of right and left initial responses is given. *From inspection of the table it is* evident that the differences are small and of low reliability. The probability that these infants are not ambidexterous is not very high, for in children a few years older one generally obtains 70 per cent or more of one-sidedness. No right: left ratio in table 4 is greater than 60:40. In short, these data do not show any pronounced asymmetry in behavior.

(3) Cephalo-Caudal Differences. Table 5 shows for each subject the percentage of leg initial responses as compared with arm initial responses, and the reliability of the differences obtained. In general, when the data for foot and arm stimulations are

combined the only reliable differences are in favor of leg initial responses. This is not due to any possible influence of the greater number of foot stimulations because the data for foot and arm stimulations were averaged so as to make their effect equal in the total percentage.

stimulation, than leg initial responses to foot stimulation. This is the case only for Subject S whose differences are of lowest reliability. The other two infants, whose differences are more reliable show the opposite tendency, presumably greater specificity when the feet are stimulated.

TABLE 4

Laterality

	BABY M				BABY S				BABY D			
	Number of Cases	Right Initial Response	Left Initial Response	$\frac{D}{\text{Sigma } D}$	Number of Cases	Right Initial Response	Left Initial Response	$\frac{D}{\text{Sigma } D}$	Number of Cases	Right Initial Response	Left Initial Response	$\frac{D}{\text{Sigma } D}$
Right Side Stimulated	109	47%	53%	0.9	64	47%	53%	0.7	80	57%	43%	1.8
Left Side Stimulated	120	60%	40%	3.2	48	46%	54%	0.8	51	58%	42%	1.6
Sum of Right and Left Stimulated	229	54%	46%	1.7	112	46%	54%	1.2	131	58%	42%	2.6

TABLE 5

Cephalo-caudal differences

	BABY M				BABY S				BABY D			
	Number of Cases	Per cent of Foot Initial Responses	Per cent of Arm Initial Responses	$\frac{D}{\text{Sigma } D}$	Number of Cases	Per cent of Foot Initial Responses	Per cent of Arm Initial Responses	$\frac{D}{\text{Sigma } D}$	Number of Cases	Per cent of Foot Initial Responses	Per cent of Arm Initial Responses	$\frac{D}{\text{Sigma } D}$
Foot Stimulations	121	69%	31%	6.3	53	49%	51%	0.1	70	84%	16%	11.0
Arm Stimulations	108	45%	55%	1.5	59	36%	64%	3.2	61	64%	36%	3.1
Foot & Arm Stimulations	229	57%	43%	3.5	112	43%	57%	2.1	131	74%	26%	8.6

If the cephalo-caudal developmental gradient is in operation in the neonate one might expect these data to be affected in one or both of two ways. First, assuming that specificity of initial response is an index of level of development, then there should be more arm initial responses to arm

Secondly, greater level of development in the anterior part of the body may be indicated by a greater number of arm initial responses than leg initial responses regardless of the stimulus. As pointed out above, this also is not the case. The reliable differences favor leg initial responses.

The Second Response. The second limb to enter into the response was characterized in two ways, namely its relation (Same, Contralateral, Homolateral, Diagonal) to the stimulated limb and its relation to the first limb to respond (Diagonal, Contralateral, Homolateral).

Table 6 shows the relation of the second responding limb to the stimulated limb as well as the relation of the first to the stimulated limb. For example the first column shows that in 33 per cent of the cases the first limb to respond was the stimulated limb. The second column shows that in 17 per cent of the cases the stimulated limb responded second. Adding these two values we get the 50 per cent in the third column, which means that the stimulated limb responded either first or second in 50 per cent of the cases. Further, in 18 per cent of the cases, for Baby M, where a first response was recorded, there was no second response or else two limbs moved simultaneously after the first. Thus there are 187 *second responses* for subject M, 89 for S and 96 for D.

In general one may conclude from table 6 that the second response occurs about equally often in the limbs diagonal to, contralateral to, homolateral to *and same as the stimulated member.* Also, the stimulated member, the diagonal and contralateral respond either first or second in from 37 to 55 per cent of the cases, and the homolateral responds either first or second in 32 to 34 per cent of the cases. Thus there is a tendency for the homolateral limb to enter into the response later than the other limbs or not at all.

The data concerning the relation of the second responding limb to the first responding limb are given in table 7. It is evident that about half of the second responses are contralateral to the first responding limb, while about one fourth are diagonal and one fourth homolateral. This indicates a pronounced tendency for arm and arm, and leg and leg to react together in time, for there are two arm-leg combinations possible to one arm-arm or leg-leg combination.

TABLE 6

The second response
Relation to the stimulated limb

	BABY M—229 CASES			BABY S—112 CASES			BABY D—131 CASES		
	Second Response	First Response	Moved First or Second	Second Response	First Response	Moved First or Second	Second Response	First Response	Moved First or Second
"Same"	17%	33%	50%	14%	36%	50%	19%	36%	55%
"Diagonal"	23%	27%	50%	17%	20%	40%	16%	21%	37%
"Contralateral"	19%	29%	48%	30%	21%	51%	14%	26%	40%
"Homolateral"	23%	11%	34%	18%	14%	32%	16%	17%	33%
No Second Response	18%			21%			35%		

DISCUSSION

A survey of the literature dealing with the behavior of the newborn reveals a great deal of immediate observational data with characterizations of behavior patterns which are of necessity couched in relatively gross

description. Seldom in the literature has an attempt been made to characterize, in responses of the type obtained in this study, the details of relations between the various components of the responses.

The responses observed in this study are in agreement with the observations of Coghill (1); Pratt (7); Pratt, Nelson and Sun (9); and Irwin (5), that the responses of the neonate to intense stimuli are generalized, that is involving the greater part of the organism. In two of the subjects 73 per cent and 77 per cent of the responses,

TABLE 7

Relation of second response to first response

	BABY M	BABY S	BABY D
"Diagonal"	23%	31%	20%
"Contralateral"	49%	44%	61%
"Homolateral"	27%	25%	19%
Number of Cases	187	89	96

as much of them as was recorded by the camera involved movement of all four limbs. In the third subject only 46 per cent of the responses involved all four limbs. In general the only responses which could not be characterized as involving the greater part of organism were those resulting from especially weak stimuli.

Pratt (7); Pratt, Nelson and Sun (9); and Irwin (5) do not stop at describing neonate responses as generalized, but go further to characterize them as random, chaotic and unorganized.[2] However, Coghill (1), whose findings have been applied to neonate behavior by Irwin (5), has maintained, as Dennis (2) indicates, that the responses are not only generalized but also patterned. He speaks of behavior patterns developing by expansion and individuation from a total, integrated pattern. But he does not deny that there may be more than one such total pattern, from which later patterns develop, in the behavior of the newborn. There may be a number of total patterns, each specific to a definite range of stimuli under a definite set of conditions (3).

In this study an attempt was made, by analyzing the time relations involved between the various component of the responses, to contribute toward a finer detail in the characterization of infant responses. Characterization of the neonate as behaving in a random manner implies a sedative finality which tends to halt analysis at the surface. It must be kept in mind that chance or randomness is nothing but a scientific construct, by which one characterizes phenomena which have not been successfully correlated with external conditions. The word random is an expression of the scientist's lack of knowledge of relationship. The aim of science is to substitute correlation for randomness.

The results of this study indicate that the responses do not occur in a chance fashion. Considering the large number of factors which remained uncontrolled, it seems highly probable that further control would yield greater constancy in responses, and thus further knowledge of correlation between conditions and behavior.

The next step indicated, therefore, would be to control factors, which were not controlled in this study, some

[2] In a series of further publications Pratt has presented data which tend to modify his earlier views (8).

of which have never to my knowledge, been controlled. Systematic control and variation of such factors as head position, flexion or extension of the limbs before stimulation, intensity of stimuli, together with further detail in analysis of behavior should establish fairly definite correlations between the behavior and the external conditions.

SUMMARY

This investigation was undertaken to characterize in one detail the gross bodily responses of newborn infants. That detail is the order of participation of the different limbs in the gross response. The subjects were stimulated by finger flips on a hand or foot alternately. Their responses were recorded by a motion picture camera and analyzed to find the first and second limbs to enter into each response.

The results show that in general the initial response occurs in the stimulated limb in about one third of the cases, in the homolateral limb in about one sixth, and in the contralateral and diagonal limbs in about one fourth of the cases each. More first responses occur in the legs than in the arms. There is no lateral dominance in the first response.

The second response appears to be unrelated to the place of stimulation but half of the second responses are contralateral to the first responding limb. The other half are equally divided between the extremities which are homolateral and diagonal to the first responding limb. This indicates a tendency for leg and leg or arm and arm rather than an arm-leg combination to react together in time. Thus the limbs which are most frequently the third and fourth to respond must lie at the opposite end of the body from the locus of the first and second movements.

In general these results have shown that although the responses are generalized, there is some patterning. The bearing of this upon theoretical considerations of neonatal behavior has been indicated.

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The Latent Memory Span of the Preschool Child[1]

HELENA MALLAY

KOFFKA, in his "Growth of the Mind," states that there are two stages in learning, the 'problem of achievement' and the 'problem of memory' and that although the problem of achievement may be solved by trial and error, instinct, training, or insight, it is the problem of memory which is most closely bound up with learning. Without reservations, Koffka asserts that 'all learning depends on memory.'

The experiment described here was set up in an attempt to investigate functioning memory, *i.e.* the latent memory span at the preschool age levels and to study the interrelationships of the problems of 'achievement' and 'memory' in the ordinary learning situation (devoid of unusual emotional tones) which the preschool child meets. Can an average latent memory span be determined for preschool children? What changes are there with age? To what extent is the latent memory span dependent on the method by which 'achievement' takes place? How much is it influenced by the emotional personality characteristics of the individual?

The problem set was to ascertain the latent memory span of the preschool child as shown in the recall of certain movements necessary for the opening of boxes. Testing memory by the recall of a series of motor responses controlled the verbal factor which is so variable at the preschool level and unduly complicates a study of memory. Latent memory spans in a variety of situations were studied and compared. Intensive analysis was undertaken of the effect on the resultant latent memory span when the simple problem of the recall of one movement was complicated by adding to it a second and third movement and when changes were made in the method by which 'achievement' took place. Discussion was directed toward the comparison of the changes in latent memory spans when the problem of memory was complicated by increasing the number of movements and by changing the method of achievement. The latent memory spans for the opening of boxes served as the constant factor in each situation. The high intercorrelations found between situations described below made tenable such comparison of results.

Subjects. The subjects were 18

[1] A report of a study presented in partial fulfillment of the requirements for the degree of Master of Arts, Department of Child Study, Vassar College. This study was carried through under the direction of Martha May Reynolds, Professor of Child Study.

children enrolled in the Vassar College Nursery School during the year 1932–1933. Table 1 gives the mean and the range of chronological ages, mental ages, and intelligence quotients of the age groups studied.

Materials. The materials consisted of three series of boxes—Types A, B, and C, described below. Type A box was one requiring for its successful opening one movement carried out in either the horizontal or vertical direction; Type B required two movements, one of which had to be carried through before the other; Type C required three movements to be carried through in a definite order. Boxes were found which were unusual, those which the subjects would not have encountered in their daily experiences.[2] The boxes all contained a small object within which served as a stimulus for opening—a car, a ring, a pencil, a ball, etc. The total number of boxes used will be given and explained in the discussion of the procedure.

TABLE 1

Chronological ages, mental ages, and intelligence quotients of age groups studied

	2 YEARS OLD	3 YEARS OLD	4 YEARS OLD
Number of cases	6	8	4
Mean C.A.	2–5*	3–5	4–2
Range	2–3 to 2–8	3–1 to 3–10	4–1 to 4–3
Mean M.A.	2–0	4–1	5–1
Range	2–6 to 3–0	3–7 to 4–10	4–6 to 5–6
Mean I.Q.	114	118	123
Range	108 to 127	100 to 132	106 to 131

* 2–5 signifies 2 years and 5 months.

Definitions. The latent memory span was defined as the longest time interval over which memory functions overtly, *i.e.* the upper time limit of the interval beginning with the first presentation of the object to the time of recall and recognition. Failure meant an evident absence of the immediate and direct pursuit of the movements necessary for the opening of the box. If the subject failed after a given interval, repetitions were made for shorter intervals until the time of the first success. If the subject succeeded, repetitions were made for longer intervals until the time of the first failure.

A *demonstration* referred to a single opening and closing by E of a single box. A *sitting* referred to the period varying from two to five minutes beginning with the subject's entrance into the examining room and continuing until the time he left to return to his play. This may have included

[2] At seven different times, E presented a new box to a subject—in all cases an older child—and in not one case was the subject able to open the box immediately without a definite period of trial and error.

more than one demonstration. The number of sittings varied with the individual subject and depended on the number of repetitions necessary to determine the latent memory span.

An *experiment* referred to a method of initial presentation carried through on all three types of boxes. Four different methods of 'achievement' were used: demonstration with visual and auditory directions, demonstration with only visual directions, trial and error and relearning, and trial and error without relearning. A *situation* referred to the further differentiation of the parts of the experiments, *i.e.* situation IA referred to Experiment I on type A box; situation IB referred to Experiment I on type B box, situation IIA referred to Experiment II on type A box, etc.

Procedure. The general procedure which remained relatively constant throughout the entire research will be given in detail for the first situation. Each of the other situations will then be discussed noting in each case only the variations from the first.

Situation IA: The subject was taken to the examining room by E. When S was seated at the table, E presented a Type A box. E shook the box and said, "There's something in here to play with. See how I open it" and showed the subject how to open the box, accompanying her movements with verbal directions, *e.g.* "we push here" or "lift this" or "pull this off." E allowed S to remove the contents—a ring, a toy auto, or a pencil—and to play with them for a few seconds. (If S made no attempt to get the object, E took it out and gave it to him.) The object was then replaced in the box, usually by S; the box was quickly closed by E and handed back to the child for the reopening. E noted whether or not S could open it immediately and directly without any false movements. *If he did,* he was allowed to play with the contents again for a few seconds, following which the box was replaced on the table and S left the examining room. *If S did not* open it correctly following demonstration, the box was removed from him (trial and error opening was not allowed) and the demonstrations were repeated, as described above, until the subject opened the box immediately and correctly when it was presented to him. The number of demonstrations required was noted.

After an interval of about twenty-four hours, S was brought back to the examining room. The box offered at the preceding sitting was re-presented. E said, "There's something here for you to play with. Do you remember this box?" The box was handed to S and E noted whether he opened it immediately and correctly. If not, E recorded a failure. An immediate success was scored a plus. Then, as this box was removed, E presented another Type A box, *i.e.* one requiring the "one" movement for its opening but which was different from the first Type A box in color, shape, and object which it contained. The procedure of the first sitting was repeated, *viz.*, E shook the box and said, "There's something else in here that's nice to play with. See how I open it." E opened it, accompanying her demonstration with verbal directions. S was allowed to play with the object inside for a few seconds after which it was replaced in the box. E closed the box and then presented it for the reopening by S. E noted whether he opened it immediately and correctly. As at the first sitting, if an incorrect start was made, the box was immediately removed and demonstrations were repeated until the box was opened directly and correctly after the presentation. Only when this was accomplished was S allowed to play with the contents. This concluded the second sitting. The number of demonstrations needed for the second box was noted as were any verbal comments made by S.

If, in this latest test for memory, S succeeded in opening the box, the test for the second Type A box took place after a longer interval, *e.g.* two or three days. If S failed

to recall the necessary movement for the opening, the next test for recall took place after a shorter interval.

This procedure of test and re-presentation of a similar problem was continued until the latent memory span was determined for the one movement. This part of the experiment, Situation IA, was then concluded.

The average number of sittings with each subject for Situation IA was 7.0. The range extended from 4 to 11. The different Type A boxes were always presented in the same order so that at the second sitting, Type A box No. 1 was presented for recall and Type A box No. 2 as the new stimulus. At the third sitting, Type A box No. 2 was presented for recall and Type A box No. 3 as the new stimulus. The upper limit of the range showed the total number of Type A boxes used in Situation IA.

Situation IB: In this situation, Type B box replaced Type A box. The details of the procedure were exactly like those in Situation IA.

The average number of sittings with each subject was 7.6; the range, 5–11.

Situation IC: In this situation, Type C box was used. The details of the procedure were exactly like those in Situation IA.

The average number of sittings was 5.4; the range, 3–10.

Situation IIA: In this situation a Type A box was again used, one requiring a single movement for its successful opening, *not*, however, the same boxes used in *IA*. Except that the demonstration was *not* accompanied by verbal direction, the initial procedure in the demonstration of the opening of boxes was identical to that in Experiment I.

The average number of sittings was 4.8; the range, 3–7.

Situation IIB: Type B box replaced Type A box. The details of the procedure were exactly like those in Situation IIA.

The average number of sittings was 4.8; the range, 3–9.

Situation IIC: Type C box was used; the procedure remained exactly the same as in Situation IIA.

The average number of sittings was 3.4; the range, 3–8.

Situation IIIA: In Situation IIIA, trial and error on the part of the subject was substituted for the demonstrations by E. S, when seated, was given a Type A box, one he had not seen before. E shook it as she handed it to him and said: "There's something in here for you to play with. See if you can get it. Open the box." *No demonstration was given.* Time was taken with a stop watch from the moment the subject touched the box with the intention of opening it to the moment he had completed the last movement and the box was open. He was allowed to remove the contents and to play with them. The contents and the box were then removed by E. Replacing the contents, E closed the box, and returned it to S for a second opening through trial and error or insight. Again no demonstration was given. Time was again taken with a stop watch. After playing with the contents for a few seconds, S returned the box and contents which were put away by E. Any comments were noted. The test for memory and the presentation of a second Type A box at the second sitting proceeded as in Experiments I and II. With each new box, trial and error opening followed by a second trial and error opening was used in place of demonstrations.

The average number of sittings was 4.7; the range, 3–8.

Situation IIIB: Type B box replaced Type A; the procedure remaining the same as that in IIIA.

The average number of sittings was 4.7; the range 3–7.

Situation IIIC: Type C box was used; the procedure as in IIIA.

The average number of sittings was 5.2; the range 3–7.

Situation IVA: Trial and error learning without relearning was used here as the method by which "achievement" took place. Following, the first complete opening, arrived at through trial and error and perhaps insight, and following a few seconds of playing with the contents, the subject returned the box to E who removed it. It was not re-presented for a reopening. The sitting ended here.

The average number of sittings was 4.4; the range, 3–7.

Situation IVB: Type B box replaced Type A box; the procedure continued as in IVA.

The average number of sittings was 5.1; the range, 3-7.

Situation IVC: Type C box was used; the procedure as in IVA.

The average number of sittings was 4.3; the range 2-7.

To recapitulate. Research had been set up to determine the latent memory spans for the recall of movements necessary in the successful opening of boxes. Comparison of results on 3 types of boxes showed the effect of increasing the difficulty of the problem on the resultant latent memory span. Variations in the problem of 'achievement,' *i.e.* demonstration, with and without verbal directions, trial and error in place of demonstration, trial and error opening, with and without relearning, were carried through to study the subsequent effects on the latent memory span. Data on personality characteristics and methods of work were kept to see the effect of atypical reactions in this field on latent memory spans and learning.

Data. The latent memory spans in terms of days for each of the twelve situations were the major part of the data. General observation and test scores of personality characteristics were used to divide the subjects into two groups—those showing fairly usual and those showing very unusual personality traits in the matter of suggestibility and amount of initiative when left undirected in a situation.

Results. Table 2 gives the average latent memory span in days for each of the twelve situations.

TABLE 2

Latent memory span for the various situations

Intervals in days

	2 YEARS OLD			3 YEARS OLD			4 YEARS OLD		
	A	B	C	A	B	C	A	B	C
Expt. I[a]	8.4	3.3	2.0	12.0	0.0	5.4	13.5	6.0	7.0
Expt. II[b]	5.8	1.8	2.0	15.1	7.7	6.1	19.8	6.3	11.7
Expt. III[c]	5.9	2.1	1.5	12.0	10.9	4.4	11.7	9.0	4.0
Expt. IV[d]	3.3	0.0	0.3	9.5	4.4	1.6	7.5	5.5	2.0

[a] Auditory and visual demonstration.
[b] Visual demonstration only.
[c] Trial and error and relearning.
[d] Trial and error—*no* relearning.

Averages per age group showed that the latent memory span in days for all boxes seemed to increase with age. The increases showed the negative acceleration frequently found in growth curves and attributed primarily to maturation. However, questions arose at this point, namely: "Could one give approximately one week as an absolute standard latent memory span over which interval a two-year old would recall movements necessary to the opening of a box?" Did not the number of movements

and the method by which 'achievement' was accomplished change the length of time over which successful recall would occur? Did not the individual personality characteristics and methods of work affect the results?

Results for Types A, B, and C boxes showed that adding to the number of movements to be recalled shortened the latent memory span; a greater decrease being found when one movement was added to a problem involving only one movement than when added to a problem involving two movements. Results in the various Experiments showed that changing the method of initial presentation resulted in a changed latent memory span; 'achievement' by trial and error producing generally shorter latent memory spans than 'achievement' by demonstration.

What then seemed to be the factors in memory and learning? There was a general tendency for an increase in latent memory spans with age and a decrease with the greater complexity of the problem. Yet inconsistent results, as shown by the entanglements of the curves (fig. 1), indicated that there was more present in resultant learning than the one item—maturation of a single function, memory. If functioning memory, the latent memory span, were wholly or predominantly dependent on maturation, it would be expected that (a) the negatively accelerated curve would be found with each type of box; (b) the more complicated boxes would lag correspondingly behind the simpler ones at proportional amounts; (c) the more complicated experiments would lag correspondingly behind the simpler ones; and (d) individual curves would follow those designated as the probable ones for the group.

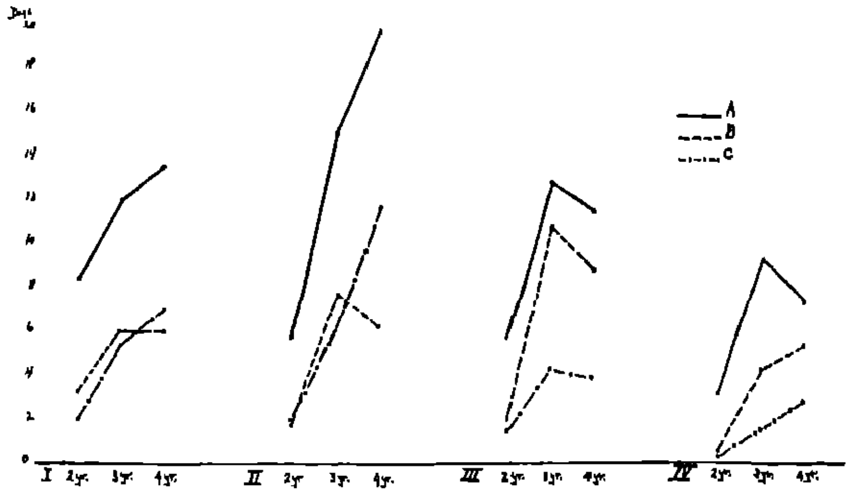

FIG. 1. LATENT MEMORY SPAN IN DAYS FOR AGE GROUPS TWO, THREE AND FOUR YEARS FOR DIFFERENT TYPES OF BOXES

The Roman numerals indicate the different experiments from I to IV

The actual graphs did not display

with any too great consistency the tendencies indicated above. An intensive analysis was undertaken of the variations in latent memory span with the different type boxes and with the different methods of presentation to see what might account for the disparity between the theoretical and the actual results. It was true that the number of cases were few. This fact might have been used to account for the results found. But analysis seemed to show that there was more involved than simply statistics and that a quantitative accumulation of subjects would not necessarily change and smooth out the curves.

In the analysis of the data gathered in Experiments I and II, it was found that the precise effect of the omission of verbal directions on latent memory spans could not be discovered in this study. Procedure called for unlimited demonstrations until S opened the box immediately following the demonstration. The number of demonstrations was always greater in II; the latent memory span was longer in II with the three- and four-year olds though not with the two-year olds. It would seem that even though S had not grasped the procedure sufficiently well to repeat the movements after the first or even second and third demonstrations, some learning might have taken place below the threshold of consciousness and acted in reinforcing the final demonstration. With two-year olds, in spite of the increase in the number of demonstrations, the latent memory span did *not* increase. Two-year olds tended to repeat verbal directions and their latent memory spans were appreciably higher when these were included in spite of additional demonstrations.

In Experiments III and IV, the box was handed to the subject to be opened through trial and error methods. In some cases, insight occurred. In others, trial and error continued until a successful accidental opening occurred. Primary interest was not in the amount of trial and error and insight and no statistical data were obtained on this point. Casual observation showed that neither trial and error nor insight seemed characteristic of any one age level. Since the aim was to get the subject to open the box without demonstration from E (this was not essentially a trial and error learning experiment), some aid was given if S began to tire and seemed loathe to continue trying. Three controls were kept in the giving of aid: (a) S was to complete all the necessary movements; (b) S was to use trial and error procedure for at least one minute before any aid was given; and (c) S was to be offered aid, if desirable, which took the form of language direction and pointing to the correct spot but not of performing the movement for the subject. In the reopening part of Experiment III, the same procedure was carried through.

A steady decrease with increasing age was found in the amount of aid needed and a steady increase with increases in the complexity of the boxes. In the relearning part of III, the per cent of times aid was needed was less than in the initial part of III and though still necessary for two-year olds was frequently not at all necessary for some of the three's and four's. Appreciably long latent mem-

ory spans were found with three- and four-year olds when 'achievement' was accomplished by a trial and error and relearning procedure. Shortest latent memory spans were found when relearning after initial trial and error opening was not permitted and were practically negligible with the two-year olds. Something seemed to be gained, however, in a single trial and error opening at all age levels in that the amount of trial and error used in an immediate reopening and the amount of aid needed was measureably reduced.

'Achievement' by means of a single trial and error procedure (IV) was followed by lower latent memory spans at all age levels and with all boxes than 'achievement' by demonstration. A trial and error and relearning procedure (III) however was *not always followed by lower latent* memory spans than those found with demonstration procedure.

Results showing a lower latent memory span for Type C box than for Type B and for Type A and a lower latent memory span after Procedure IV and III than II and I respectively were the general conclusions. Of the individual curves for the two-year olds, 88 per cent corroborated these data; for the three-year olds, 75 per cent; for the four-year olds, 63 per cent. Individual results showing Type B or/and Type C with longer latent memory spans than Type A or Experiment III with longer latent memory spans than II or I were occurring with greater frequency with the older children.

EVK, a well adjusted child of superior intelligence with a calm coöperative mind set, showed *the average results very well in* her graphs. MM, also a child of superior intelligence, with a highly negativistic personality who resisted demonstrations, who wished to do everything for herself, made *remarkably higher scores in trial* and error experiments which she obviously enjoyed. JAS, a reserved and too easily suggestible child, who showed little initiative, who looked to an adult constantly for permission to proceed, scored significantly lower on the trial and error experiments than on the demonstration ones. HS, who appeared more engrossed and attentive when complicated directions were being demonstrated and who disdained the seemingly simple, *made better scores on Type C following* demonstration than on Types A and B. Trial and error procedures at which times he went plunging blindly and with little direction and insight caused him great difficulty before he finally succeeded. His methods of work were such that failure to open the box, rather than stimulating him to further effort, tended to discourage him. He repeated with little self-consciousness, "I can't. You help me. No, I can't." And he proceeded to tug blindly. Trial and error for him proved to be of little value especially with the more difficult boxes.

RESULTS

1. Latent memory spans increased with age, generally following the negatively accelerated curve but showed variations which might have occurred when factors other than maturation alone were involved in the learning situation.

2. Latent memory spans were longer when 'achievement' was accomplished by demonstration involving auditory and visual stimuli than just the visual stimuli.

3. The number of demonstrations was greater when verbal directions were omitted.

4. Latent memory spans increased with increases in the number of demonstrations. Two-year olds were evi-

dently dependent on verbal directions to assist them in directing and maintaining their gaze for the visual directions. For them, increasing demonstrations without verbal directions did not result in increased latent memory spans, as it did with the three- and four-year olds, who were less dependent on verbal directions and profitted by the increase in demonstrations to increase latent memory spans.

5. Latent memory spans were usually shorter when trial and error procedure took the place of demonstration in the 'problem of achievement.'

6. Latent memory spans were negligible with two-year olds and with some three-year olds when relearning was not permitted after the trial and error opening.

7. With two-year olds, 'achievement' by demonstration with verbal directions resulted in the longest latent memory spans; trial and error and relearning resulted in short but appreciable ones; results after a single trial and error opening were negligible. Depending upon the procedure used for 'achievement,' the latent memory span range was:

	days
Type A box	3.3–8.4
Type B box	0.6–3.3
Type C box	0.3–2.0

8. With three- and four-year olds, an increased number of demonstrations (even though omitting verbal directions) resulted in longest latent memory spans; trial and error and relearning gave appreciable ones; single trial and error opening gave shortest ones. Depending upon the procedure used for 'achievement,' the latent memory span range for three-year olds was:

	days
Type A box	0.5–15.1
Type B box	4.4–10.9
Type C box	1.0– 6.1

and for four-year olds:

	days
Type A box	7.5–19.8
Type B box	5.5– 9.0
Type C box	2.0–11.7

9. The latent memory spans of subjects showing atypical personality traits and methods of work were correspondingly atypical in the light of the results found above.

It would seem that in learning, there was involved more than the one item—maturation of the functioning of memory. The richer experience of older children upon which they build associations does in general result in longer latent memory spans—the premise of maturation. But personality characteristics and methods of work have definite effects on latent memory spans. Wherever such personality traits and methods of work with regard to the situation were considered 'unusual,' unusual results were found in functioning memory. Functioning memory was also found to be inextricably tied up with the problem of 'achievement' and the complexity of the gestalt to be recalled. No absolute latent memory spans can be given even in an unemotionally toned learning situation such as described here—not even for the recall of movements in the successful opening of boxes.

Learning is dependent on memory, and functioning memory—the actual

latent memory span—seemed to be dependent on: (1) the complexity of the problem, (2) the method by which 'achievement' was accomplished, and (3) the personality characteristics and methods of work of the individual.

The interdependence of personality traits and method of 'achievement' in resultant learning should especially be noted. It raises the question of whether one should give special consideration to personality types and choose the most profitable method of achievement for maximum results in learning or whether one should attempt to change atypical personality traits, to bring them within the normal range for the greatest possible gain from *each* of the various methods of achievement.

Certainly for the two-year old, there seemed to be a necessity for verbal directions during a demonstration to assist him in directing and maintaining his gaze in order to grasp what was offered during the demonstration.

The Development of Concepts of Magnitude

Martha E. Thrum

THE development of the ability of children to perceive relative sizes of objects and make correct responses to the relation is a subject about which we know little. It is rather apparent that children have concepts which differ from those of adults in regard to comparative sizes of objects in their environment. It is often noted that a child misjudges size in relation to himself as is demonstrated by his look of surprise when he cannot sit in a chair made for a doll.

Attempts have been made to gain more complete and accurate information as to just how a child interprets things about him. This problem is particularly difficult with the very young child because of his inability to comprehend language and the greater limitation in conveying his thought through language which is intelligible to adults. This difficulty with language makes it necessary to attack the problem in a very simple and often indirect manner. Perhaps because of the comparative recency of planned research in child psychology, and perhaps because of the difficulties encountered in attempts to secure information regarding the extent of a child's ability to interpret relationships from an adult point of view, little work has been done on the subject.

Oppenheim (6) says that a child learns very gradually to associate visual impressions with proper relations of objects in space, and that his undeveloped power of accurate observation added to this, is bound to make his reports unreliable. Johnson (5) states that the child's perception of differences in the size and form of objects doubtless excels his ability to indicate his discrimination.

The purpose of this study was to obtain information on the development of abstract concept of magnitude for children from two to five years of age. The relative differences in size of geometric forms was chosen as a means of securing this information. For such young children it was necessary to have the procedure and language used as clear as possible. The sets of geometric forms were so planned that for each set of a given form the relative differences in size were varied. The sets included the familiar forms of circles, squares, and triangles, and were made of black cardboard. For a small group a further set was used which included colored forms. The colors used were red, green, yellow, and blue.

The investigations so far undertaken which bear on the problem of a child's concepts of size, fall into the fields of

form perception, the recognition of relationships, and the learning of relative sizes. There has been considerable work done on form and color combined in the same experiment in an attempt to determine which of the two elements tends to influence a child's selection: if there is a preference shown at what age this appears, how long a child tends to prefer color to form or vice-versa, and what factors seem to bring about a change of preference. These studies are primarily a study of preference and few investigations report data on the perception of the relative size of an object in comparison with others. A brief review of these experiments will suffice to illustrate the great need for further work.

Baldwin and Stecher (1) used the Montessori cylinders to test discrimination of difference in the diameters and heights of cylindrical inserts and their corresponding holes. Three sets of 10 cylinders were used, the first varying in diameter, the second in both diameter and height, and the third in height only. The inserts were placed and taken out again in front of the child before he was asked to perform the test. It was reported that several children took out correctly placed cylinders in the hope of forcing into the hole another cylinder for which a place could not be found, and that much trial and error experimentation went on.

The Montessori tower was used for perception of differences in size. It is comprised of ten blocks to be placed one on another in order of size. The tower was first built by the experimenter, then knocked down, and the child was asked to build it in the same way. The smaller blocks seemed easier than the larger ones. Perfect performance was impossible for the two-year-olds. The time necessary to complete the performance decreased with an increase in age. The authors say that the Montessori tower is an attractive and familiar occupation for young children and gives an immediate index of the development of a child's knowledge of size relationships.

An experiment by Rice (8) on the orientation of plane figures, though it uses figures of uniform size throughout the experiment, involves a keenness of perception similar to that involved in the discrimination of slight size differences. The problem was to test, if possible, the age when a child either will, negatively, refuse to recognize *sameness* in two figures which are identical, but not in the same position on the page, or will, positively, indicate by some word or action that they would be the same if one or the other were turned part way around.

The portion of the study important for consideration was a test of discriminative perception in the selection of a design regardless of position such as the perception of diamonds vertically and horizontally placed in the first test period, and of two spoons, vertically and horizontally placed in the second test period. The tests were given to 226 children between the ages of two years seven months and nine years three months. In the tests the scores depended on the number of correct perceptions including the accuracy of orientation.

The conclusions were that the orientation on the page of plane figures

appears to rise rather suddenly as a factor in their perception between the ages of five and six, or between the standard kindergarten age and the standard first grade age. The break is apparently rather sudden for the individual child with little or no transition; and for the group it may be located much more exactly than one might expect. The degree of similarity with the figures used in the perception tests seems to bear little or no relation to the reaction toward the orientation of the figures on the part of the child.

Piaget (7) holds that young children are unable to interpret relationships unless they are definitely concerned with themselves. On the other hand, Isaacs (4) and Hazlitt (2) found that children at a very young age were able to perceive and respond to relations that involved fine discriminations and a certain knowledge of relationships, but were unable, in many cases, to state these relationships because of their limited use of language. Other investigators interested in a child's ability to make judgments found that, in general, young children were able to see relative differences before they were able to state them.

A study of the *Learning of Abstract Concepts of Size* was undertaken by Hicks and Stewart (3). This is, as far as could be ascertained, the only experiment which deals with the abstract concepts of size irrespective of color or form and is of particular interest.

The problem was to test two to five year old children on their ability to learn to select the middle size of three boxes. Six boxes were used. They were cubes open on one side and varied in size from fourteen centimeters to four centimeters. All were covered with red paper. A small toy was always placed under the middle-size box in order to help motivate its selection and to identify the correct response to the child.

The 6 boxes made up 4 series with 3 boxes in each. Each series was presented in such order that after a child had learned to select the middle-size box in one group, he was shown a new combination from which the *largest* box of the previous series had been dropped and a new *smallest* box added. By varying the position of the boxes during each series the factor of position as a possible basis of learning was eliminated. During a single practice period the 5 positions of a series were repeated 5 times. Thus 15 trials or choices were made by a child in the course of each practice period. Each series was presented until the child made a perfect record on the 15 trials constituting a practice period. The next series was presented at the next practice period. A child was dropped at the end of the sixth practice period if he did not get more than a third of the responses correct. The interval between practice periods was never less than one or more than three days.

There were 40 children used in this experiment: 10 in each group for ages two, three, four and five years. The examiner placed a screen in front of the boxes when arranging them; then said, "now we are going to play a new game. Here is a middle-size box, a big box (pointing), and a tiny box (pointing). There is a toy under the middle-

size box, but there is nothing under the big box or tiny box (lifting each box up to demonstrate). Remember, the toy is always under the middle-size box." Before beginning the test on the succeeding days, the examiner said, "do you remember how we played our game? The toy was always under the middle-size box. All right, find the toy for me."

The authors summarize their results as follows: The test was beyond the ability of 9 of the 10 two-year-olds; 52 per cent of the choices of the 9 children who failed the test were made on the basis of the position of the box; the 31 children who completed the test gave almost no evidence of selection on the basis of position; the number of errors and the number of practice periods decreased with age; success in learning the test correlated highly with the mental age for 10 of the three-year-old children; direction of attention to the boxes and an interest in making the correct choices were factors in success; the children who completed the test confused the middle-size box with the large one twice as often as with the smallest one; 68 per cent of the errors made by the 31 children who completed the test were on Series 1. Once having learned the concept of *middle-sizeness* in the first series of boxes, they were able to apply this concept to the succeeding series.

The writer's experience with children under experimental conditions, leads her to think that the low percentage of success among the younger groups might have been due to the long practice periods. The authors state that "direction of attention to the boxes and an interest in making correct choices were factors in success." Since a child was obliged to complete a practice period at one sitting, and since each practice period required 15 trials or choices, is it any wonder that a two-year-old child lost interest? Another factor which the writer questions is that a child was dropped at the end of the sixth practice period if he did not get more than a third of the responses correct. This is requiring the same standard for the two-year-olds that was required of the five-year-olds. To say that a two-year-old cannot learn to select the middle-size of 3 boxes because he takes a greater number of trials to do so, is hardly correct. It would be interesting had the experimenters found out how many trials were required of each age group.

PROBLEM

This investigation, a report of which follows, is concerned with the development of the concept of magnitude. The major problem was a study of a child's development of the concepts of big, little, and middle size, irrespective of the particular sizes presented. The experiment covered a period of several months. In this experiment there were three series of tests given: A preliminary series, or Series X; a series forming the main study, or Series Y; and a supplementary series, or Series Z in which colored cards were employed. The children who reacted in this study were enrolled in the Child Institute of the Johns Hopkins University. They ranged in age from two to four and a half years at the begin-

ning of the study. The records of 34 children were used. There were 20 boys and 14 girls.

Method and Results

Series X. The materials used in the preliminary series of this experiment were as follows: 3 bright red toy automobiles measuring $4\frac{1}{2}$ inches, 3 inches, and an $1\frac{1}{4}$ inches respectively in length; 3 white paper circles the diameters of which measure 4 inches, $2\frac{1}{4}$ inches, and $\frac{3}{4}$ inch respectively; 3 white squares, the sides of which measure 4 inches, $1\frac{1}{3}$ inches, and $\frac{1}{3}$ inch respectively. The automobiles were used because they were familiar to and liked by all the children. They were exactly alike except in size. The objects in Series X were presented in the following order: cars, circles, squares, and triangles. The children were allowed to play with the cars for a few minutes before they were placed in position for the experiment. If a child wanted to continue playing, he was told that after playing the "game" with the experimenter he could play with the cars alone for a few minutes.

In the testing situation the examiner placed the cars on a table in front of the child who sat opposite, then gave the directions: "Look at these (pointing to objects) very carefully and give me the one I ask you for. Give me the biggest one." The first sentence of the above directions was repeated for each testing situation. The second sentence was varied according to the relative size of the object which the particular test situation called for. The positions in which the materials were presented, and the size which the examiner asked for, are indicated in the chart given below;

Position	*Sizes requested*
1. Big, little, middle size	Big
2. Big, little, middle size	Little
3. Big, little, middle size	Middle size
4. Middle size, little, big	Middle size
5. Middle size, big, little	Middle size

It will be noticed that the object intermediate in size was never placed in the middle position in this series. The order of presentation and size requested, as given in the chart, were followed for all materials used in Series X. The subject was given no indication of the correctness of his choice. Only one choice was required of a subject at each sitting, *i.e.* five sittings were necessary to complete Series X.

Results. The results have been tabulated in various ways in order to find out what factors seemed to influence a child's choice of a particular size. The data are analyzed for the number of errors made in response to requests for particular sizes of objects in relation to the other objects presented and also for the order of presentation with reference to size. The possible influence of the form of the object is also considered.

The data for errors made in response to requests for a particular size, either big, little, or middle size, are given in table 1. By far the greatest number of errors were made for the middle size, fewer for the little one, and least for the big one. We find that 88 per cent of the choices were correct when the big object was requested, 68 per cent when the little object was requested, and 48 per cent when the middle size was requested. The per-

centage of errors in 20 choices ranged from zero to eighty per cent, with a mean of 41.6 per cent of errors for the group. Five children out of 25 chose correctly for all selections of the three sizes. These children ranged in age from three years eleven months to four years eight months. The greatest number of errors made for the three sizes was 16 out of 20 choices, made by 2 children, 1 three years and eleven months old, and the other two years and five months old.

TABLE 1

Series X

Errors made in relation to size requested

REACTOR	AGE	NUMBER OF ERRORS: Size requested: Big	Little	Middle	Total	ERRORS IN 20 CHOICES
						per cent
1	2–1	4	3	7	14	70
2	2–	0	3	0	3	15
3	3–4	0	2	7	9	45
4	3–3	0	2	0	2	10
5	3–	0	0	12	12	60
6	3–6	0	0	10	10	50
7	2–11	0	2	11	13	65
8	3–1	0	1	12	13	65
9	3–11	4	4	8	16	80
10	3–11	0	0	0	0	00
11	2–5	0	0	12	12	60
12	2–5	0	4	12	16	80
13	3–2	0	3	12	15	75
14	2–4	2	1	9	12	60
15	3–7	0	0	0	0	00
16	4–6	0	0	8	8	40
17	4–	0	0	1	1	05
18	4–6	0	0	0	0	00
19	3–5	0	2	11	13	65
20	2–7	2	4	9	15	75
21	2–4	0	0	2	2	10
22	3–8	0	1	1	2	10
23	4–8	0	0	0	0	00
24	4–5	0	0	0	0	00
25	4–7	0	0	12	12	60
Total errors..........		12	32	156	200	
Number of choices...		100	100	300		
Per cent wrong.......		12	32	52		
Per cent correct......		88	68	48		

TABLE 2

Series X

Percentage correct for order of presentation

REACTOR	PERCENTAGE CORRECT — Order presented: BLM	MLB	MBL
1	41	25	00
2	75	100	100
3	50	100	25
4	83	100	100
5	67	00	00
6	67	00	50
7	50	00	25
8	58	00	00
9	100	100	100
10	33	00	00
11	67	00	00
12	33	00	00
13	41	00	00
14	58	00	25
15	100	100	100
16	67	00	100
17	92	100	100
18	100	100	100
19	58	00	00
20	17	00	75
21	83	100	100
22	83	100	100
23	100	100	100
24	100	100	100
25	67	00	00
Mean.....	68	45	52

The mean per cent of correct choices for the order of presentation, BLM (big, little, and middle size) in which all 3 sizes were requested, was 68. For the order MLB, in which only the middle size was requested, there was a mean per cent of correct choices

of 45. The data for individual children are given in table 2. With the exception of one child, we find that the children were either 100 per cent correct in their choice of the middle size for all forms presented, or were 100 per cent incorrect. Eleven out of the 25 children were 100 per cent correct. The mean per cent of correct choices of the middle size in the order MBL was 52. There were 11 children who were 100 per cent correct in their selections in this order of presentation.

Another factor involved in the problem was the difference in form of the objects used. In table 3, the number of errors made for each of the forms presented are given. As has been stated above, the cars were used because of their immediate appeal. On the whole, fewer errors were made with the cars than with the geometric forms, the circles, squares, and triangles; but the difference was slight. Sixty-three per cent of the choices involving the cars were correct, 58 per cent correct for the circles, 59 per cent correct for the squares, and 60 per cent correct for the triangles.

Summary. The results indicate that more children were familiar with the idea of *big* in relation to the other two sizes presented than they were with little or middle size. Only 4 out of the 25 children made errors in their selection of the big forms, while 13 made errors when selecting the little one, and all but 7 made errors in their choice of the middle size form. The ages of the 4 children who made errors for the big form were two years one month, two years four months, two years seven months, and three years eleven months. These children made errors in their selections of the little and middle size forms also. Among those who made no errors in their

TABLE 3

Series X

Errors made in relation to form presented without reference to size requested

REACTOR	ERRORS MADE				
	Cars	Forms presented			Total
		Circles	Squares	Triangles	
1	2	4	4	4	14
2	0	1	1	1	3
3	1	3	3	2	9
4	0	1	0	1	2
5	3	3	3	3	12
6	2	2	3	3	10
7	3	3	4	3	13
8	3	3	4	3	13
9	4	4	4	4	16
10	0	0	0	0	00
11	3	3	3	3	12
12	4	4	4	4	16
13	3	4	4	4	15
14	3	3	3	3	12
15	0	0	0	0	00
16	2	2	2	2	8
17	1	0	0	0	1
18	0	0	0	0	00
19	3	4	3	3	13
20	3	5	3	4	15
21	1	1	0	0	2
22	2	0	0	0	2
23	0	0	0	0	00
24	0	0	0	0	00
25	3	3	3	3	12
Total errors	46	53	51	50	200
Number of choices	125	125	125	125	
Per cent wrong	37	42	41	40	
Per cent correct	63	58	59	60	

selection of the big forms there were 4 who were not three years lod. They ranged from two years to two years

and eleven months. It would appear therefore that age had very little, if any, influence over the accuracy of selections.

It is difficult to determine what effect the order of presentation of the three sizes had upon the choices. In the positions MLB and MBL, in which only the middle size was requested, more errors were made in the first of these positions than in the second, but whether this was due to the position or to a learning factor, it is impossible to say.

Another factor which was analyzed in order to determine its effect upon the accuracy of selections was the difference in forms presented. Although the cars, which were presented first, were chosen correctly more often than the three geometric forms, the difference was not great, and the difference in relative accuracy among the geometric forms was negligible. It appears therefore that the various forms used had no appreciable influence on the correctness of the choice.

The accuracy of selections in this series seems to have been determined by the previous experiences of the child, rather than by any factors involved in the experiment itself.

Method and Result

Series Y. Following the preliminary series which was intended primarily to secure coöperation and understanding of instructions, Series Y was given. This series was presented to a group of 15 children twice, and to a group of 19 children once only. A retest was given to one group after an interval of 6 months to obtain an indication of the effect of ordinary experiences upon the development of concepts after the stimulation of the test experience. The materials were sets of black cardboard circles, squares, and triangles differing in size by 1 inch, ½ inch, and ¼ inch in diameter or length of side. The largest circle was 3 inches in diameter and the smallest 1 inch; the largest square and triangle measured 3 inches on a side, and the smallest measured 1 inch. For each geometric form the order of placement relative to size was the same: that is,

Circles	Squares	Triangles
BLM	MBL	LMB

B represented big, L represented little, and M represented middle size. There were five steps which involved varying differences in the sizes of the forms used. The first step included forms that differed from each other by 1 inch in diameter or length of side, the second by ½ inch, and the third by ¼ inch. In the fourth step there was a difference of 1 inch between the biggest and middle size card; in the fifth there was ½ inch between the biggest and the middle size card, and ¼ inch between the middle size and the little card. A sixth step was introduced in which all the three forms used were 1 inch in diameter or in length of side. The last step was used as a check on a child's understanding of the problem. The remarks made by the children were recorded by the experimenter. The directions were the same as for the other five steps, *i.e.* the child was requested to give the examiner the biggest, littlest, or middle size one. As in Series X, the geometric forms were placed on a table

in front of a child who sat opposite the examiner.

The positions in which the forms were presented and the sizes requested are indicated in the following chart:

Group A

Circles, Position BLM. Big requested in the six steps.
Squares, Position MBL. Big requested in the six steps.
Triangles, Position LMB. Big requested in the six steps.

Group B

Circles, Position BLM. Little requested in the six steps.
Squares, Position MBL. Little requested in the six steps.
Triangles, Position LMB. Little requested in the six steps.

Group C

Same forms and positions as in Groups A and B. Middle size requested.

In this series the middle size was put in the intermediate position once. A child was requested to make only three choices a day. He was, for example, asked to select the big size form in the first step of the first group above, for the circles, squares, and triangles. The next day, he completed the second step in which the differences in size of the forms varied from the preceding step. This procedure was continued until he had finished the six steps for the three forms. A similar procedure was followed for the second group B, in which the little size was requested, and for the third group C, in which the middle size was requested. The directions given were the same as those used in the preliminary series; that is, the child was requested to give the examiner the biggest, littlest, or middle size one according to the particular test situation.

Results. The same factors were considered in the tabulation of the results of this series as were considered in Series X.

In table 4, the number of errors made in relation to the size requested is given. We see that although the number of children who were correct in their selection of the big forms was less than the number of those who were incorrect in their selection of the little forms, the total number of errors made to the request for the biggest was greater than for the little form. Ten children made 61 errors in the selection of the biggest and 12 children made 48 errors in the selection of the little card. This gives a percentage of correct choices of 88 for the biggest and 91 for the littlest form. The number of errors made in selecting the middle size was significantly larger. Only 6 out of 34 children were constantly correct in their selection of this size. There was a total number of errors for the group of 264, which gave a percentage of correct choices of only forty-eight. The six children who were correct in their selections of this size were correct also in all their selections of the big and little forms. The youngest child to choose all forms correctly was three years and three months; the others ranged from three years and seven months in age to four years and eight months. The percentage of errors in 45 choices ranged from zero to sixty-seven, with a mean of 22.

The various arrangements of the sizes used made it possible to have 6

TABLE 4

Series Y

Errors made in relation to size requested

REACTOR	AGE	NUMBER OF ERRORS: Size requested: Big	Little	Middle	Total	PER CENT ERRORS IN 45 CHOICES
1	2–4	6	2	15	23	51
2	2–3	0	0	14	14	31
3	3–4	0	0	2	2	04
4	3–6	0	0	0	0	00
5	3–4	0	0	1	1	02
6	3–0	0	2	2	4	09
7	3–1	0	0	11	11	24
8	3–5	1	0	15	16	35
0	4–2	4	0	2	6	13
10	4–1	0	0	14	14	31
11	3–1	0	0	12	12	24
12	2–8	0	0	12	12	24
13	3–5	0	1	10	11	24
14	2–4	13	0	9	22	49
15	3–0	0	0	0	0	00
16	4–8	0	0	0	0	00
17	4–2	0	0	0	0	00
18	4–8	0	2	5	7	15
19	3–7	0	1	15	16	35
20	2–11	4	2	7	13	29
21	2–7	6	3	14	23	51
22	3–10	0	0	8	8	18
23	4–10	0	0	0	0	00
24	4–8	0	0	0	0	00
25	4–10	0	0	1	1	02
26	4–11	0	1	6	7	15
27	3–7	6	0	15	21	47
28	3–8	0	0	8	8	18
29	2–3	7	10	11	28	62
30	3–6	0	0	1	1	02
31	2–3	3	15	12	30	67
32	2–5	11	3	12	26	58
33	3–0	0	0	15	15	33
34	3–0	0	6	15	21	47
Total errors		61	48	264	373	
Number of choices		510	510	510		
Per cent wrong		12	09	52		
Per cent correct		88	91	48		

TABLE 5

Series Y

Percentage of correct responses for varying differences between size of form requested and of form selected

REACTOR	DIFFERENCE IN INCHES BETWEEN DIAMETERS OR LENGTH OF SIDES: 2	1½	1	¾	½	¼	MEAN
1	100	83	67	100	70	61	80
2	100	100	83	100	80	72	89
3	100	100	97	100	100	95	99
4	100	100	100	100	100	100	100
5	100	100	95	100	100	100	99
6	100	100	100	100	100	78	96
7	100	100	100	100	80	72	92
8	100	100	90	100	80	61	88
9	100	100	89	100	97	83	95
10	100	100	83	100	80	72	89
11	100	100	100	100	80	67	91
12	100	100	95	100	80	72	91
13	100	100	83	100	87	78	91
14	100	100	83	100	70	45	83
15	100	100	100	100	100	100	100
16	100	100	100	100	100	100	100
17	100	100	100	100	100	100	100
18	100	100	83	100	90	95	95
19	100	100	85	100	80	60	87
20	67	100	78	100	87	83	86
21	100	100	67	100	67	60	82
22	100	100	100	100	80	89	95
23	100	100	100	100	100	100	100
24	100	100	100	100	100	100	100
25	100	100	100	100	100	95	99
26	100	100	95	100	90	83	95
27	100	67	78	67	80	67	76
28	100	100	100	100	87	78	94
29	83	83	50	83	63	67	72
30	100	100	100	100	100	95	99
31	33	50	45	50	61	83	54
32	67	67	72	67	70	67	68
33	100	100	83	100	80	67	88
34	100	100	78	100	73	50	84
Mean	95	95	87	96	86	76	

size differences in the 6 steps of this phase of the experiment. Table 5 shows us the percentage of correct responses for varying differences be-

tween the size of the form requested and the form selected. The actual measurements of these differences in inches were 2; 1.5; 1; 0.75; 0.50; and 0.25. The mean per cents of correct choices for the group of 34 children for these differences between the size of the form requested and the form selected were 95, 95, 87, 96, 86, and 79, respectively. These percentages indicate greater difficulty for the smallest differences in size of forms, with the exception of the one inch difference. This variation in trend appears to be due to a few low scores for that size difference that were highly influential upon the mean for so small a group. The trend toward greater difficulty with smaller size differences is indicated by the decrease in percentage correct for the majority of the group. In this table will be found also the mean of the percentages of correct choices for each child for all these size differences. The range was from fifty-four to one hundred per cent correct.

The results were analyzed with regard to the possible effect of the order of presentation of the three sizes upon the accuracy of selections. Table 6 shows that the mean percentage of correct selections for the three orders BLM, MBL, and LMB was 76, 75, and 76, respectively. This would indicate that the order of presentation did not influence the selections.

The number of errors made by each child for each of the three forms used was approximately the same. Nine children made all their selections of may be seen in table 7. The total number of errors made for each form circles and squares correctly, and 10 children made their selections of triangles correctly.

TABLE 6

Series Y

Percentage correct for order of presentation

REACTOR	PERCENTAGE CORRECT		
	Order presented		
	BLM	MBL	LMB
1	47	47	53
2	67	67	73
3	87	100	100
4	100	100	100
5	93	100	100
6	93	80	100
7	73	73	80
8	60	67	67
9	67	73	67
10	93	93	73
11	73	73	73
12	80	73	67
13	87	67	93
14	47	47	60
15	100	100	100
16	100	100	100
17	100	100	100
18	87	73	93
19	60	67	67
20	73	80	60
21	67	33	47
22	80	87	80
23	100	100	100
24	100	100	100
25	100	93	100
26	87	80	87
27	53	53	53
28	100	73	73
29	27	53	33
30	100	100	93
31	40	33	27
32	47	40	40
33	67	67	67
34	40	60	60
Mean...	76	75	76

Only 15 children commented on the sixth step of this series in which all three sizes of the 3 forms presented

TABLE 7

Series Y

Errors made in relation to form presented without reference to size requested

REACTOR	NUMBER OF ERRORS			
	Position and form presented			Total
	BLM Circles	MBL Squares	LMB Triangles	
1	8	8	7	23
2	5	5	4	14
3	2	0	0	2
4	0	0	0	00
5	1	0	0	1
6	1	3	0	4
7	4	4	3	11
8	6	5	5	16
9	1	1	4	6
10	5	4	5	14
11	4	4	4	12
12	3	4	5	12
13	5	5	1	11
14	8	8	6	22
15	0	0	0	00
16	0	0	0	00
17	0	0	0	00
18	2	4	1	7
19	6	5	5	16
20	4	3	6	13
21	5	10	8	23
22	3	2	3	8
23	0	0	0	00
24	0	0	0	00
25	0	1	0	1
26	2	3	2	7
27	7	7	7	21
28	0	4	4	8
29	11	7	10	28
30	0	0	1	1
31	9	10	11	30
32	8	9	9	26
33	5	5	5	15
34	9	6	6	21
Total errors..	124	127	122	373
Number of choices.....	510	510	510	
Per cent wrong......	24	25	24	
Per cent correct.....	76	75	76	

were alike. All the other children selected a form without saying anything. The remarks are recorded below. The numbers representing particular children correspond to those used in the tables.

These comments give emphasis to the results from the other forms in showing that some children have a clear perception of relative differences. Some children show stability in judgments of size relations and others appear less secure, indicating that the ages studied form a period of rapid development of concepts of magnitude.

Summary. The results of Series Y are in agreement with those found in the preliminary series. The majority of the children had little trouble in making their selections when the biggest and the littlest forms were requested, but most of them seemed unable to select the middle size of the three forms, regardless of the actual differences in size between the forms. Although the largest differences were between the two extremes of the three presented, the differences between the middle-size in relation to the other two were large and the children had no difficulty in reacting to those differences when they involved selections of the big or little.

The concept of middle-sizedness proved to be much more difficult than that of big or little size. As has been pointed out, the factors of age, order of presentation, and forms used seemed to have been insignificant in their influence upon the accuracy of selections.

Retest, Series Y. A retest in Series Y was given to a group of fifteen children after a summer vacation. This

REACTOR	AGE	SIZE REQUESTED	REMARKS
2	2-3	Little	"Well, they're all little."
5	3-4	Big	"I can't find the biggest one."
		Middle	"They're so little I don't know which is the middle-size one."
7	3-1	Middle	"You mean that big one?" (The forms in the other five steps had been placed in the order MBL.)
9	4-2	Big	"Didn't look like the biggest one." "Had to look carefully 'cause I had to see which was the biggest one."
		Little	"I can't tell which is the littlest one. They seem all big, don't they?"
		Middle	"I don't see any to give you. I'll give you this one." (Chose one on his right.)
10	4-1	Big	"It hasn't any biggest one." "There isn't any biggest one on this one."
		Little	"They're all little."
		Middle	"Those are little."
11	3-1	Big	"Where is it?"
12	2-8	Big	"It's no big one. This one must be it." (Handed me one on her left, where the big one had been in the previous five steps where the position had been BLM.)
13	3-5	Middle	"These were the same size, weren't they?"
14	2-4	Big	"These littlest ones. Those are little ones. Those are little ones."
		Middle	"All these middle-size ones."
26	4-11	Big	"Where's the biggest one?"
27	3-7	Big	"Was that the biggest one?" (Chose one in middle. Order was LMB.)
16	4-8	Middle	"They're so small, aren't they? I don't know what's the matter with them."
19	3-7	Middle	"They're all middle size."
23	4-10	Little	"I can hardly tell which is the little one of these." (On the following day when the various sizes in the first step were presented she said: "I know which is the middle size of these because the middle-size one is more middle-size."
		Middle	"I can hardly tell. Could'nt tell with those because they're all the same size."
25	4-10	Little	"They're all little ones, aren't they? Oh, is this the one? It looks like it." (Chose the one on his right.)

was done in order to find out what effect their experiences during those four months would have upon the

accuracy of their selections, and to refamiliarize the children with the test situation before introducing the next phase of the experiment. The method of procedure was the same as that used in the original test.

Results. The children made no errors in their choices of the big forms, as is shown in table 8, only 2 errors when making a selection of the little forms, and 75 errors when selecting the middle-size forms. Three children made all their selections of the 3 sizes correctly. The percentage of errors in 45 choices ranged from zero to thirty-three, with a mean of 11.

TABLE 8

Series Y, Retest

Errors made in relation to size requested

REACTOR	AGE	NUMBER OF ERRORS: Size requested: Big	Little	Middle	Total	PER CENT ERRORS IN 45 CHOICES
1	3–1	0	0	11	11	24
2	3–0	0	0	3	3	07
3	4–0	0	0	6	0	13
4	4–3	0	0	1	1	02
5	4–0	0	1	3	4	09
6	4–6	0	0	0	0	00
7	3–10	0	0	4	4	09
8	4–1	0	1	14	15	33
9	4–10	0	0	6	6	13
10	4–9	0	0	0	0	00
11	3–9	0	0	1	1	02
12	3–5	0	0	1	1	02
13	4–4	0	0	10	10	22
14	3–0	0	0	15	15	33
15	4–6	0	0	0	0	00
Total errors........		0	2	75	77	169
Number of choices..		225	225	225		
Per cent wrong.....		00	00.8	33		
Per cent correct....		*100*	*99.2*	*67*		

The mean percentages of correct choices for the six differences in size between the forms requested and those selected are tabulated in table 9. For the size differences of 2, 1½, 1, ¾, ½, and ¼ inches we find mean percentages of 100, 100, 96, 100, 94, and 87 respectively. In other words, the *difference of 2 inches, 1½ inches, and* ¾ inch were chosen correctly 100 per cent of the time; the difference of 1 inch was chosen correctly 73 per cent of the time; that of ½ inch was chosen correctly 40 per cent of the time; and the difference of ¼ inch 20 per cent of the time.

TABLE 9

Series Y, Retest

Percentage of correct responses for varying differences between size of form requested and form selected

REACTOR	DIFFERENCE IN DIAMETER OR SIDE, IN INCHES: 2	1½	1	¾	½	¼	MEAN
1	100	100	83	100	83	83	91
2	100	100	100	100	97	80	96
3	100	100	100	100	90	83	95
4	100	100	100	100	100	95	99
5	100	100	100	100	97	83	97
6	100	100	100	100	100	100	100
7	100	100	100	100	97	83	97
8	100	100	83	100	83	81	88
9	100	100	100	100	90	80	96
10	100	100	100	100	100	100	100
11	100	100	100	100	100	95	99
12	100	100	100	100	100	95	99
13	100	100	89	100	87	78	92
14	100	100	83	100	80	67	88
15	100	100	100	100	100	100	100
Mean.	100	100	96	100	94	87	96

Table 10 shows us the mean percentage of correct choices for the order of presentation. We see that for the

order BLM the group made a mean percentage of correct selections of 87, for the order MBL a mean percentage of 87, and for the order LMB a mean percentage of 92.

An analysis of the number of errors made for the three forms used is shown in table 11. We find that 18, or the fewest errors, were made for the triangles, 30 for the squares, and 29 for the circles.

TABLE 10

Series Y_1 Retest

Percentage correct for order of presentation

Reactor	Percentage correct: Order presented BLM	MBL	LMB	Total
1	80	67	80	227
2	93	93	93	279
3	80	87	93	260
4	100	93	100	293
5	80	93	100	273
6	100	100	100	300
7	87	100	87	274
8	67	60	73	200
9	100	100	100	300
10	93	80	87	260
11	93	100	100	293
12	100	93	100	293
13	67	67	100	234
14	67	67	67	201
15	100	100	100	300
Mean	87	87	92	

A comparison of the first and second tests in Series Y shows us a decided improvement in the retest. There were 24 errors in the selections of the big forms in the first test and none in the retest. In the selections for the little forms in the first test there were 5 errors and in the retest only 2. In the selections of the middle-size forms there were 119 errors in the first test and 75 in the retest. One child who had made 14 errors out of 15 selections for the middle-size form in the first test made no errors for this size in the retest.

TABLE 11

Series Y_1 Retest

Errors made in relation to form presented without reference to size requested

Reactor	Number of errors: Form presented BLM Circles	MBL Squares	LMB Triangles	Total
1	3	5	3	11
2	1	1	1	3
3	3	2	1	6
4	0	1	0	1
5	3	1	0	4
6	0	0	0	0
7	2	0	2	4
8	5	6	4	15
9	1	3	2	6
10	0	0	0	0
11	1	0	0	1
12	0	1	0	1
13	5	5	0	10
14	5	5	5	15
15	0	0	0	0
Total errors	29	30	18	77
Number of choices	225	225	225	
Per cent wrong	13	13	08	
Per cent correct	87	87	92	

The trend for the mean percentages of correct choices for the varying differences between the size of the forms requested and those selected is the same for the retest as we found in the first test. All the children improved in their individual selections for the six differences except three.

The mean percentages of correct choices for these three children showed the largest decrease to be four points.

The mean percentages of correct selection for the order of presentation for the retest showed a considerable improvement, with a similar trend toward greater accuracy in selection of the middle-size form when it was presented in the middle position. Similar results were found in the analysis of the number of errors for the forms presented.

Method and Results

Series Z, Colored Forms. Colored forms were introduced in an attempt to find out whether the children would be influenced by color when the choice was to be made for size. It was assumed that the introduction of color might have an index of reliability of previous selections. The material for this series consisted of a set of colored geometric forms, circles, squares, and triangles of the same dimensions as those used in Series Y. They were presented in similar manner with the same size relationships maintained step by step as had been used in Series Y. In this series the sixth step in which all three forms were the same size was omitted. In the order of presentation of the colors, care was taken not to have any color occur more often than another, or in any position more often than another. The colors used were red, blue, yellow, and green. Black forms were mixed with the colored ones.

Instead of requiring the children to complete only one step of the experiment a day, as had been done in Series X and Series Y, they were requested to complete 3 steps 1 day and 2 the next. The 3 steps required nine choices a day, which took, at most, ten minutes. If, for any reason, the experimenter decided that a child was not concentrating on the task, the test period was shortened and he was requested to make only three choices. This series was presented to 24 children.

Results. Table 12 is a tabulation of the number of errors made in relation to the size of the form requested. We find that all the children except three were able to make correct selections when the biggest forms were requested. Those 3 children made 16 errors. Six children were incorrect in their selections of the littlest forms, and they made 20 errors altogether. These low percentages of errors, 4 per cent for the big form and 5 per cent for the little form, were not found for the middle size. When this size was requested 18 children made 140 errors, giving us a percentage of errors of 38, which is a considerable decrease in accuracy. Only 6 children were 100 per cent correct in all their selections of the 3 sizes.

Data for an analysis of the results with respect to the percentage of correct responses for the varying differences between the size of the form requested and the form selected are given in table 13. There were 6 possible differences, measured in inches, between the diameters or length of sides of the forms used. We find a mean per cent correct for the group of 98, 98, 91, 98, 90, and 84, for the differences of 2, 1½, 1, ¾, ½, and ¼ inches respectively. The 2 children who chose incorrectly when there were

differences of 2 inches, 1½ inches, and ¼ inch between the size of the form requested and that selected were the youngest in the group.

TABLE 12

Series Z

Errors made in relation to size requested

REACTOR	AGE	NUMBER OF ERRORS: Size requested: Big	Little	Middle	Total	PER CENT ERRORS IN 45 CHOICES
1	3–4	0	0	11	11	24
2	3–3	0	0	0	0	00
3	4–3	0	0	2	2	04
4	4–6	0	0	0	0	00
5	4–4	0	0	5	5	11
6	4–9	0	0	0	0	00
7	4–2	0	0	7	7	15
8	4–4	0	0	7	7	15
9	5–1	0	0	4	4	09
10	5–2	0	0	0	0	00
11	4–1	0	0	0	0	00
12	3–10	0	0	0	0	00
13	4–8	0	1	2	3	07
14	3–4	0	0	15	15	33
15	4–0	0	0	1	1	02
26*	4–11	0	1	15	16	35
27	3–0	3	2	9	14	31
28	3–10	0	0	10	10	22
29	2–5	4	6	12	22	40
30	3–8	0	0	3	3	07
31	2–5	9	7	10	26	58
32	2–7	0	3	10	13	29
33	3–11	0	0	9	9	20
34	3–1	0	0	8	8	18
Total errors		16	20	140	176	
Number of choices		360	360	360		
Per cent wrong		04	05	38		
Per cent correct		96	95	62		

* The reactors designated in previous series by the numbers 16–25 were not tested in Series Z.

In table 14, we found that the mean percentage of correct choices was greatest for the triangles, the 3 sizes of which were always placed in the order LMB. If the differences between the triangles and the squares and circles had been greater, we may have explained it by the fact that the triangles were presented last, but the difference is so slight that this factor may be considered negligible.

TABLE 13

Series Z

Percentages of correct responses for varying differences between size of form requested and form selected

REACTOR	DIFFERENCE IN INCHES BETWEEN DIAMETERS OR LENGTH OF SIDE: 2	1½	1	¾	½	¼	MEAN
1	100	100	83	100	87	78	91
2	100	100	100	100	100	100	100
3	100	100	100	100	100	80	98
4	100	100	100	100	100	100	100
5	100	100	100	100	90	89	06
6	100	100	100	100	100	100	100
7	100	100	100	100	90	78	05
8	100	100	89	100	90	89	95
9	100	100	100	100	93	89	97
10	100	100	100	100	100	100	100
11	100	100	100	100	100	100	100
12	100	100	100	100	100	100	100
13	100	100	95	100	100	89	97
14	100	100	83	100	80	67	88
15	100	100	100	100	90	100	98
26	100	100	83	100	80	61	87
27	100	100	78	100	80	45	84
28	100	100	89	100	87	78	92
29	83	83	72	83	70	72	77
30	100	100	100	100	97	89	97
31	83	67	61	67	73	67	69
32	100	100	83	100	80	72	89
33	100	100	83	100	90	83	93
34	100	100	83	100	97	95	96
Mean	98	98	91	98	90	84	85

The order of presentation of the 3 sizes had as little influence upon the

accuracy of selections in this series as in the two previous series. The mean per cent of correct choices for the orders BLM, MBL, and LMB were 82, 84, and 85, respectively. The individual scores can be found in table 14.

TABLE 14

Series Z

Percentage correct for order of presentation

REACTOR	PERCENTAGE CORRECT		
	Form and Order presented		
	Circles BLM	Squares MBL	Triangles LMB
1	67	80	80
2	100	100	100
3	87	100	100
4	100	100	100
5	87	87	93
6	100	100	100
7	80	87	87
8	87	87	80
9	100	100	100
10	87	100	87
11	100	100	100
12	100	100	100
13	93	93	93
14	67	67	67
15	100	100	93
26	67	67	60
27	53	60	93
28	100	67	67
29	33	60	60
30	93	100	87
31	20	47	60
32	73	67	73
33	80	80	80
34	93	67	87
Mean...	82	84	85

The number of errors made in relation to the form presented without reference to size requested is analyzed in table 15. We find that the total number for the circles, squares, and triangles was 65, 59, or 52 errors respectively. The greatest number of errors made by a child was 26 out of a possible 45 choices, made by a girl two years and five months old. These errors were for the three forms: 12

TABLE 15

Series Z

Errors made in relation to form presented without reference to size requested

REACTOR	ERRORS MADE			
	Position and Form presented			Total
	BLM Circles	MBL Squares	LMB Triangles	
1	5	3	3	11
2	0	0	0	0
3	2	0	0	2
4	0	0	0	0
5	2	2	1	5
6	0	0	0	0
7	3	2	2	7
8	2	2	3	7
9	2	0	2	4
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	1	1	1	3
14	5	5	5	15
15	0	1	0	1
26	5	5	6	16
27	7	6	1	14
28	0	5	5	10
29	10	6	6	22
30	1	0	2	3
31	12	8	6	26
32	4	5	4	13
33	3	3	3	9
34	1	5	2	8
Total errors..	65	59	52	176
Number of choices.....	360	360	360	
Per cent wrong......	18	16	15	
Per cent correct.....	82	84	85	

for the circles, 8 for the squares, and 6 for the triangles.

An analysis of the relative accuracy of choices involving five colors, including black, is based upon data given in table 16. We see that the mean per-

TABLE 16

Series Z

Percentage correct for all sizes and forms

REACTOR	BLUE	GREEN	RED	YELLOW	BLACK	MEAN
1	70	86	71	75	78	76
2	100	100	100	100	100	100
3	100	100	85	100	90	95
4	100	100	100	100	100	100
5	89	85	100	91	82	89
6	100	100	100	100	100	100
7	89	87	100	90	69	87
8	90	75	87	89	80	84
9	100	100	87	82	90	92
10	100	100	100	100	100	100
11	100	100	100	100	100	100
12	100	100	100	100	100	100
13	90	100	78	100	100	94
14	67	67	83	64	60	68
15	100	100	100	100	90	98
26	75	67	83	54	56	65
27	87	67	62	64	50	66
28	78	78	85	73	87	80
29	57	60	72	44	83	63
30	90	100	85	100	90	93
31	28	50	55	46	37	43
32	100	55	75	67	50	69
33	78	80	85	76	85	81
34	80	78	85	83	85	82
Mean	86	85	86	83	82	84

centages of correct selections for blue, green, red, yellow, and black were 86, 85, 86, 83, and 82, respectively. The small differences in errors for the varying colors indicate that the color of the form had little influence upon the selections made for relative size.

Although there were 16 errors made in the selection of the big form, all of them were made by the group of children numbered in table 12 from twenty-six to thirty-four. The entire series of tests from X to Z had been presented to these children within a period of six months. The first group of 15 children received the tests over a period of a year and three months. They received also a retest in Series Y which gave them greater familiarity with the test, and a period during which added experiences doubtless increased their ability to see abstract relationships. None of the 15 children made an error when selecting the big form in this series. Since we find the same trend in the selections of both the little and middle-size forms, the lengthened period and additional testing were doubtless influential factors in the selection of all three sizes. Six children out of nine who were given all 3 series during six months chose the big form correctly. They included a child of four years and eleven months, and one two years and seven months. Age does not seem to have been any more influential in this series than in the two previous series, except that the two children who made the greatest number of errors in all their selections were the youngest in the group. However, the child who came third in the total number of errors was the oldest in the group. Two children made all their selections for the middle size forms incorrectly. They both chose the smallest forms which were in the intermediate position when the middle size was first requested. These children were three years and four months, and four years and eleven months of age.

Summary. In Series Z, we have considered the factor of color as an influential factor in selection for relative size. We find that the results resemble closely those found in Series Y. The results from the color series give additional evidence of the greater difficulty in perception of the relation of middle size than for that of little or big. It is also shown that, in general, the greater the difference between forms, the more accurate is the choice. This is in agreement with the results of Series Y. We have also found that age, form, and the order in which the sizes were presented have probably not been determining factors in the choices.

The introduction of colored forms which might be assumed to introduce an interfering factor gives results that emphasize the early development of the concept of magnitude, though particular relations between sizes of objects, as middle size, are not equally developed at a given age.

CONCLUSION

The results from this study show that at the age of 3 years some children have developed concepts of magnitude though instability in perceptual reactions to varying relations between the sizes of objects is manifested. Inaccuracy in response to some situations does not indicate absence of a concept of size. This is indicated by the large percentage of children who make correct responses in selection of the largest object, though in another series that same object may have been the smallest. There is a perception of the relative difference in size. Correct choices of the smallest object were not so frequent as for the biggest though many children of the group were consistently correct.

The perception of the middle-size relation, in which the child must perceive that one object is smaller in relation to another object though it is correspondingly larger than the third object, is not a well developed concept at the ages studied. However, some children under five are capable of making correct responses in situations demanding the perception of intermediacy.

The extent of the differences in size influences slightly the response made. If the differences in size between objects are very small, the discrimination of the differences becomes difficult, and the perception of relative differences becomes increasingly inaccurate. With the size differences presented in this study, the three relations were perceived for all sizes though the middle-size relation was more difficult to perceive. Responses to the smaller size differences show slight increase in inaccuracy.

The tests for stability of the concept of magnitude—the color series and the presentation of a series with no difference in size of objects—substantiate the conclusion that some children develop a concept of magnitude earlier than others. Other children perceive differences in size but are not stable in perception of relative differences, under the varying conditions of presentation.

Individual differences in response do not clearly indicate definite age differences in the ability to select objects with reference to relative size. There is a trend toward less accuracy

in the younger children but some of this group excel some in the older group. Below 3 years of age there was a tendency toward making the same selection throughout the series. This would seem a failure to interpret the instructions. Preference for certain sizes or certain positions may have been influential. Control in the test procedure was not sufficient to state from the results whether the children perceived the relations. It is evident that some children 3 years of age have formed a concept of magnitude. The results point to the conclusion that the children were not influenced in their selections by the forms of the objects presented; that the sizes requested were presented in different orders did not seem to affect their choices; and also that the introduction of color in the last series did not affect the accuracy of their choice. The children's selections, then, must have been made after consideration of the sizes themselves. The conclusion that the child's ability to make perceptual judgments was a basis of his choice, seems justified from the data presented.

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Inter-Relationships of Motor Abilities In Young Children

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ONE of the questions which persistently intrudes itself in the study of motor skill has to do with the possible existence of a general factor of motor ability which is to some degree independent of variations in age, sex, physical size and strength, intelligence and similar traits. Expressed somewhat differently, the question is whether or not motor abilities involving different muscle-groups and differing in apparent complexity show any tendency to vary concomitantly in the same individual when other factors, such as those noted above, are held constant.

For many reasons, the optimum time to study this question seems to be the years of early childhood, before differential practice and unequal motivation from outside sources have too far complicated the results. Although it is recognized that even among children from two to six, important differences in interests and experience unquestionably exist, nevertheless there can be no denial that whatever modification of original behavior-tendencies may have been induced thereby, these modifying influences have had a far shorter time to exert their effects when the subjects are studied in early childhood than is true in the case of adults. Childhood likewise seems to be the time when such questions as the existence of sex differences in pattern of ability is of most significance, since by tracing such differences backward to earlier and earlier ages there is greater possibility of ascertaining their origin in nature or nurture. Another question which takes on particular significance if studied during the early years before interests and habits have become too firmly set, has to do with the persistence of individual differences in specific abilities over a period of time. This is a question which has provoked much discussion and a large amount of experimental investigation in the field of intelligence measurement, but one which has scarcely been touched as far as motor skills are concerned.

With the foregoing questions in mind, the Institute of Child Welfare at the University of Minnesota undertook an investigation which was designed to throw some light on these problems. All children attending the nursery school and experimental kindergarten were given a series of brief tests of motor abilities at annual intervals. The testing schedule was so arranged that all children were tested at the period mid-way between the annual birthdays, that is, at ages 2½, 3½, 4½, and 5½. The maximum amount of variation from the defined age was one month in either direction.

In the great majority of cases, the deviation from the standard age was only a few days. Since motor abilities change so rapidly with age during the period of childhood, the importance of controlling the age factor in studies of this kind can hardly be over-estimated.

The following tests were used:

I. *Time required for walking a 25-foot line.* The apparatus for this test consisted of a 25-foot length of white paper, down the center of which had been gummed a strip of one-inch brown paper such as is used for sealing parcels. We used this in preference to the well-known "walking board" for two reasons: first, because walking boards were used as standard equipment in the nursery school which meant that the children had had a variable amount of previous experience with them, and secondly because it seemed desirable to employ a longer test than is afforded by the walking board of conventional length. While a 25-foot board is possible, it is a cumbersome bit of apparatus, especially when storage space is limited. Preliminary investigations indicated that the walking path is quite as reliable a measuring device as the walking board, although the type of motor ability which it measures is probably not identical with that measured by the walking board in which the factor of balance plays a greater part.

Our procedure in giving this test was as follows. The strip of paper was spread down a hallway at a time when this part of the building was not in use. The examiner said, "I want to see how straight you can walk. Here is a little narrow path. See if you can walk all the way down without stepping off the path even once. Watch me and see how I do it." The examiner then walked the length of the line slowly and carefully, repeating at intervals as she did so, "You see I have to be very careful. I have to watch to see just where to put my feet so I won't step off." On reaching the end of the line she said to the child, "Now let's see how well you can do it. Be sure to step right on the path every time." The examiner then took up a position at the end of the path where the child's steps could be watched accurately. The child was placed at the opposite end of the path, facing the examiner, who said, "Now see how fast you can walk all the way down the little path to me. Do it as fast as you can but be sure not to step off the path." The stop watch was started when the child took his first step and was stopped as soon as he reached the end of the line. Three trials, taken in immediate succession, were given but only the results of the second and third have been included in the results. The first trial was treated as a fore-exercise.

II. *Number of errors made in walking a 25-foot line.* Errors were counted by observation of the number of times the child stepped off the path. Although this method of counting errors is somewhat subjective, it was found that simultaneous observers agreed very closely in their count. In the majority of instances the records obtained in this way tallied exactly, and disagreements amounting to more than one error rarely occurred. Only

the number of errors made in the second and third trials have been included in our results.

III. *Finger Tapping with the Comptometer.* The procedure used was identical with that employed in an earlier study by Goodenough and Tinker (1). The child to be tested was seated before a key-drive adding machine (the comptometer). The tapping procedure was first demonstrated by the experimenter, after which a brief preliminary trial was given so that the child might "see how it works." The experimenter then said, "Now I am going to see how fast you can tap with this finger alone" —(touching index finger of right hand). "Get ready so you can start when I say, 'go.' Ready—go!" The stop watch was started simultaneously with the first tap, not at the word, "go," since young children sometimes fail to start promptly on signal. Likewise the examiner was careful to take such a position that the indicator could be read as the word "stop" was pronounced at the end of the time limit, thus minimizing the errors due to individual differences in the children's reaction-time. After the index finger of the right hand had been tried, the examiner said, "Now I am going to see which of your fingers can work fastest. Let's try this one next," touching the index finger of the left hand. Thereafter the order was as follows: Middle finger of right hand, middle finger of left hand, little finger of right hand, little finger of left hand. Short rest periods, during which the examiner chatted with the child or gave him a toy to play with, were interspersed between the trials. The time allowance was 10 seconds for each finger.

After this series, known as the unimanual series since only one hand was used at a time, had been completed, the examiner said, "Now we'll have the two hands run a race. Use these keys" (touching the two corner keys in the bottom row) "and tap just as fast as you can with both hands together." The two index fingers were tried first, then, after a rest period, the two middle fingers were tried, and then, following a second rest period, the two little fingers. This is known as the bimanual series. A separate report in which the detailed results of this test and that of test No. VI (stylus tapping), will appear in a forthcoming article (2). In the present study the total number of taps made with each finger by both methods have been summed for purposes of correlation with the other tests.

IV. *Time required to thread a series of five needles of varying size.* The apparatus used for this experiment is the needle threading test distributed by the Stoelting Company, Chicago (Cat. No. 10215). The set of five needles was placed before the child in the holder provided with the test. A short length of fine wire, the diameter of which was a trifle less than half that of the eye of the smallest needle was used in place of a thread. The examiner said, "I want to see how good you are at threading needles. Let's play that this piece of wire is a thread and see how quickly you can put it into the eye of each of these needles

in turn. Watch to see how I do it." After demonstrating the procedure, the examiner handed the wire to the child saying, "Now see how fast you can thread them." Time was taken on each needle separately, and the sum of the times on all five needles was used as the child's score. It was found better to time the needles separately, since, in spite of instruction, some of the younger children would stop to talk or to wait for further instruction after one needle had been threaded before passing on to the next. A brief rest period was taken after the series had been completed, and then a second trial was given for the purpose of determining the reliability of performance from trial to trial. A time limit of two minutes for the entire series was used.

V. *"Three-hole test." Number of thrusts with each hand in a 10-second period.* The apparatus used for this test is the well known "Three-hole test" devised by Fernald and supplied by Stoelting (Cat. No. 19307). The procedure in giving this test was similar to that used in other tests of the series. After demonstration by the examiner, the child was urged to thrust the stylus into each of the three holes in turn as rapidly as possible. A 10-second trial with each hand was given, followed by a rest period after which the test was repeated in the same manner as before. The score is the sum of the number of thrusts with the two hands on the two trials combined as recorded by an electrical counter.

VI. *Tapping with stylus on metal plate with electrical counter.* As with the finger tapping, the procedure used with this test is identical with that in the previous study by Goodenough and Tinker (1). The child was instructed as to the manner of holding the stylus and the position of the arm and hand. Verbal instruction was followed by demonstration by the examiner, and by a short fore-exercise in which any departures from the standard procedure were noted and corrected. Tapping was done for a period of ten seconds with each hand, after which a rest period was given and the test repeated as before.

VII. *Simple reaction time.* The procedure and the detailed results for the reaction-time experiment have been reported elsewhere (3). The apparatus used was the Miles Reaction Board (4). Twenty reactions, ten with each hand, were obtained for all cases, and the median time taken as the score for an individual child.

With the exception of the reaction time test, which was taken on a separate occasion, all tests were given at a single sitting. The total time required did not exceed 20 minutes. The reaction time test, which was given on a separate day, usually required about 10 minutes at most. Motivation was not difficult to secure or to maintain, since the sittings were relatively short and the material used was varied and interesting to the children. Moreover, since all the children were attending the experimental nursery school and kindergarten of the University of Minnesota, they were well habituated to the laboratory procedure and surroundings. The tests were given by research assistants in the Institute whom the children knew and with

whom they felt completely at ease. Each assistant who took part in the experiment was given a period of preliminary training in the manner of giving the tests to make sure that a constant procedure would be followed by all. Only the records of those children who took all the tests and who evinced a high level of coöperation throughout the entire series have been included in the results.

Table 1 shows the means and standard deviations of scores on the motor tests for each of the four age-groups studied. Except for the reaction-time test, the values given in this table are the sums of the scores on the two trials given. The reaction-time values represent the means of the individual scores at each age. An individual score, it will be recalled, is the median of 20 reactions made in immediate succession and expressed in sigma units.

TABLE 1

Means and standard deviations of scores on motor tests by age

AGE	NUMBER OF CASES	WALKING PATH				FINGER TAPPING		NEEDLE THREADING		THREE-HOLE TEST		STYLUS TAPPING		SIMPLE REACTION-TIME	
		Time		Errors											
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
2½	20	22.7	5.4	23.7	10.6			122.4	113.2			103.5	26.4		
3½	24	31.5	18.8	13.1	8.5	163.5	50.2	50.2	50.9	36.7	9.9	130.1	10.2	67.0	23.8
4½	30	24.1	11.8	6.0	4.7	238.8	52.1	50.5	28.4	46.2	10.6	154.0	36.3	48.2	12.7
5½	80	21.7	9.4	3.1	2.3	201.1	51.5	32.8	17.4	56.2	11.1	151.5	27.3	45.0	15.1

As was to be expected, there is a general improvement in the scores earned on all tests with advancing age. This is represented either by a decrease in the length of time required to perform a test, or by an increase in the amount accomplished during a set time. The only exceptions to this rule are to be found in the length of time required for the walking path by the children of two-and-a-half years, and in stylus tapping by the children of five-and-a-half years. The first is probably to be ascribed to a difference in the kind of performance most typical of the younger children as compared to that of the older groups. In general the younger children tended to be relatively oblivious to errors; or perhaps the explanation is that they did not know how to avoid making errors. They watched the line and apparently tried to step on it each time, but few of them seemed to have grasped the idea that by retarding their speed they could get better control over the exact placing of their feet. The average time for this age-group is shorter than that for either of the two age-groups following it, and is only slightly longer than that for the children of five-and-a-half years. Practically all the children at this age behaved in a very uniform fashion, which is indicated by the small size of the standard deviation. This indicates that in all probability we are dealing with a true characteristic of the normal two year old child, and that the results obtained can not

safely be ascribed to a fluctuation in sampling.

The second break in the curve of improvement with age is to be seen in the average score in stylus tapping when the children of five-and-a-half years are compared with those of four-and-a-half. In this case, however, chance fluctuation seems to be the more probable explanation. Examination of the distribution of scores and comparison with those obtained in the previous study by Goodenough and Tinker makes it appear likely that the average obtained for the children of four-and-a-half is slightly higher than would be obtained from other samplings drawn from the same population, while that for the children of five-and-a-half is somewhat too low.

The coefficients of variability do not change greatly with age, although a slight decrease with advancing age is apparent for certain tests. In general, however, the ratio of the standard deviations to the mean is fairly constant. Some writers have been inclined to look upon the coefficient of variability as a measure of the reliability of the tests. While this is a somewhat questionable assumption, it may be noted that errors on the walking path and time required for the needle threading test show the highest variability coefficients, while the two tapping tests rank lowest in this respect.

The figures presented in table 1 are for the sexes combined since separate treatment of the findings for the boys and girls showed only very small differences between the means with almost complete overlapping of the distributions. The small differences that appeared may be summarized as follows: In the reaction-time test the boys surpassed the girls at all ages but the differences amounted to only two or three sigma. The girls were slightly superior to the boys in needle threading and in the three-hole test, both of which involve fine manual coördination A possible superiority of the boys on both tapping tests was indicated but not reliably established.

Table 2 shows the reliability coefficients for the several tests by ages separately. In interpreting these figures it should be recalled that the range of ages within a given age-class is very short, and that the coefficients herein presented are therefore but little affected by age heterogeneity. With the exception of the number of errors made on the walking path by the children of five-and-a-half years, and the needle threading test for the children of four-and-a-half or older, the correlations are encouragingly high when the short time-allowance for the various tests is taken into account. The lowered reliability in the three instances mentioned is in large part due to the fact that for children of these ages the test has become too easy to be a significant measure of individual differences in ability.

A note with regard to the probable errors given in the last column of table 2 may be desirable. The ordinary formula for the probable error of a correlation coefficient does not take account of the fact that, as the correlations approach unity, the distribution of the probable errors becomes more and more skewed. In other words, the probability that in other samples drawn from the same popula-

tion the obtained coefficients would diverge from those obtained in the present investigation by the amount of one, two, or three probable errors in the direction of zero is much greater than the probability of a corresponding divergence in the opposite direction. Two methods have been proposed to compensate for this factor,—the substitution of Fisher's z function for the coefficient of correlation and the upon the existence of some degree of relationship between the two variables considered. The reporting of the probable error of a correlation of zero obtained from a given number of cases is a procedure that has been frequently employed in biometrics but has been less commonly used in psychological or educational statistics.

Tables 3 to 9 show the intercorrelations of the various tests with each

TABLE 2

*Reliability coefficients of motor tests for single age-groups**

AGE	N	WALKING PATH		FINGER TAPPING†	NEEDLE THREADING	THREE-HOLE TEST	STYLUS TAPPING	SIMPLE REACTION	P.E. WHEN r = .00‡
		Time	Errors						
		r	r	r	r	r	r	r	
2½	20	.86	.04		.92		.90		.15
3½	24	.90	.92	.84	.90	.87	.82	.80	.14
4½	30	.83	.90	.00	.65	.87	.85	.81	.12
5½	80	.84	.64	.77	.53	.85	.02	.92	.07

* All coefficients are calculated by the Pearson product-moment method and, with the exception of the finger tapping, they are based on the correlation between first and second trials given at the same sitting and corrected by the Spearman-Brown prophecy formula.

† The reliability coefficient of the finger tapping is based upon the sum of the scores for three fingers of each hand in unimanual tapping vs. the corresponding sum for bimanual tapping. Previous investigations have shown that this correlation is likely to be somewhat lower than the true reliability coefficient based upon scores obtained by the repetition of the test when the same method is used for both trials.

‡ Computed by formula: $\text{P.E.}_r = .6745 \dfrac{1 - r^2}{\sqrt{N - 1}}$.

simpler procedure of reporting, in all cases, the probable error of a correlation of zero obtained from the same number of cases. Only when r equals zero will the probable errors of r be distributed symmetrically in both directions. The probable errors given in table 2 indicate the likelihood of obtaining a correlation of the magnitudes reported if the true correlation were zero. That is, they indicate the amount of reliance that can be placed other at successive ages. In general, these intercorrelations are low and, if considered separately, would merit little consideration, but a comparison of the directions of the relationships at various ages suggests certain general trends. It was therefore thought worth while to make a factor analysis of the results according to Thurstone's method (5, 6, 7). Application of this technique suggests the existence of at least one common factor running

through all the tests and indicates also the probability of one or more group factors entering into several of them. The loadings for these factors at each of three age-levels are shown in tables 10 and 11.

TABLE 3

*Correlation of speed on walking path with other variables at successive ages**

AGE	N	WALKING PATH, FEWNESS OF ERRORS	FINGER TAPPING	SPEED, NEEDLE THREADING	THREE-HOLE TEST	STYLUS TAPPING	SIMPLE REACTION SPEED	P.E. WHEN r = .00
		r	r	r	r	r	r	
2½	20	+.24		+.10		−.04		.15
3½	24	−.01	−.21	−.22	+.18	−.27	−.34	.14
4½	30	+.18	+.01	−.20	+.32	−.10	+.15	.12
5½	80	−.02	+.00	−.18	.00	−.11	+.14	.07

* In this and all succeeding tables, the scores have been so arranged that a positive sign preceding a correlation coefficient indicates correspondence in the direction of improvement while a negative sign signifies that as one variable showed improvement the other showed a decrement. Thus, since a shorter time for the walking-path test is a mark of improvement as is also a greater number of thrusts on the three-hole test. The positive correlations reported in Table 3 with the three-hole test signify that as time decreased (or speed increased) the number of thrusts increased.

TABLE 4

Correlation of fewness of errors on walking path with other variables at successive ages

AGE	N	WALKING PATH, SPEED	FINGER TAPPING	SPEED, NEEDLE THREADING	THREE-HOLE TEST	STYLUS TAPPING	SIMPLE REACTION SPEED	P.E. WHEN r = .00
		r	r	r	r	r	r	
2½	20	+.24		+.37		+.53		.15
3½	24	−.01	−.27	−.11	+.31	−.08	+.13	.14
4½	30	−.18	−.10	+.26	+.53	+.00	+.24	.12
5½	80	−.02	+.08	+.21	+.20	+.20	+.21	.07

TABLE 5

Correlation of scores on finger tapping with other variables at successive ages

AGE	N	WALKING PATH, SPEED	WALKING PATH, FEWNESS OF ERRORS	SPEED, NEEDLE THREADING	THREE-HOLE TEST	STYLUS TAPPING	SIMPLE REACTION SPEED	P.E. WHEN r = .00
		r	r	r	r	r	r	
3½	24	−.21	−.27	+.26	+.54	+.40	+.15	.14
4½	30	+.01	−.10	+.34	+.51	+.40	+.17	.12
5½	80	+.00	+.08	+.22	+.21	+.17	+.32	.07

In view of the small number of cases at the two lower ages and the conse-

TABLE 6

Correlation of speed of needle threading with other variables at successive ages

AGE	N	WALKING PATH, SPEED	WALKING PATH, FEWNESS OF ERRORS	FINGER TAPPING	THREE-HOLE TEST	STYLUS TAPPING	SIMPLE REACTION SPEED	P.E. WHEN r = .00
		r	r	r	r	r	r	
2½	20	+.19	+.37			+.27		.15
3½	24	−.22	−.11	+.20	+.30	+.42	+.16	.14
4½	30	−.20	+.26	+.34	+.39	−.03	−.02	.12
5½	80	−.18	+.21	+.22	+.38	−.03	−.03	.07

TABLE 7

Correlation of scores on the three hole test with other variables at successive ages

AGE	N	WALKING PATH, SPEED	WALKING PATH, FEWNESS OF ERRORS	FINGER TAPPING	SPEED, NEEDLE THREADING	STYLUS TAPPING	SIMPLE REACTION SPEED	P.E. WHEN r = .00
		r	r	r	r	r	r	
3½	24	+.18	+.31	+.54	+.30	+.08	+.14	.14
4½	30	+.32	+.53	+.51	+.39	+.05	+.18	.12
5½	80	.00	+.20	+.21	+.38	+.23	−.04	.07

TABLE 8

Correlation of scores on stylus tapping with other variables at successive ages

AGE	N	WALKING PATH, SPEED	WALKING PATH, FEWNESS OF ERRORS	FINGER TAPPING	SPEED, NEEDLE THREADING	THREE-HOLE TEST	SIMPLE REACTION SPEED	P.E. WHEN r = .00
		r	r	r	r	r	r	
2½	20	−.04	+.53		+.27			.15
3½	24	−.27	−.08	+.40	+.42	+.08	−.08	.14
4½	30	−.10	+.00	+.40	−.03	+.05	+.22	.12
5½	80	−.11	+.26	+.17	−.03	+.23	+.11	.07

TABLE 9

Correlation of simple reaction speed with other variables at successive ages

AGE	N	WALKING PATH, SPEED	WALKING PATH, FEWNESS OF ERRORS	FINGER TAPPING	SPEED, NEEDLE THREADING	THREE-HOLE TEST	STYLUS TAPPING	P.E. WHEN r = .00
		r	r	r	r	r	r	
3½	24	−.34	+.13	+.15	+.16	+.14	−.08	.14
4½	30	+.15	+.24	+.17	−.02	+.18	+.22	.12
5½	80	+.14	+.21	+.32	−.03	−.04	+.11	.07

quent high probable errors of the intercorrelations upon which the factor analysis is based, exact agreement of the obtained loadings from one age to another could not be expected. There is reason to think, moreover, that the true loadings as obtained from populations of infinite size would change somewhat with advancing age. It is highly improbable that the organization of abilities in children of three years corresponds exactly with that of the same children at the age of five. More in accordance with our present knowledge of child development is the viewpoint that as the child grows, different types of ability come into prominence which, in their turn, will give place to others as growth proceeds. In other words, not only the absolute level of ability but its most typical pattern undergoes a series of progressive changes with age. Nevertheless, we should not expect to find that these changes occur so rapidly in the child of preschool age that the pattern becomes kaleidoscopic. Some degree of resemblance in the factors underlying the relationships of one type of performance to another and hence some degree of similarity in the factor loadings for a given test at

TABLE 10

Factor loadings for the several tests

Factor I

	AGE		
	3½	4½	5½
Speed, walking path	−.384	+.105	−.088
Fewness of errors, walking path	−.104	+.422	+.385
Speed, finger tapping	+.780	+.578	+.380
Speed, needle threading	+.611	+.372	+.408
Three-hole test	+.359	+.828	+.711
Stylus tapping, speed	+.540	+.340	+.330
Reaction-speed	+.208	+.380	+.102

TABLE 11

Factor loadings for the several tests

Factor II

	AGE		
	3½	4½	5½
Speed, walking path	−.278	−.087	−.217
Fewness of errors, walking path	−.314	+.763	−.200
Speed, finger tapping	+.045	−.466	−.308
Speed, needle threading	−.031	+.209	+.308
Three hole test	+.796	+.102	+.223
Stylus tapping	−.300	−.330	−.263
Reaction speed	+.183	−.016	+.514

successive levels of performance is logically to be expected. It is quite possible, for example, that the gain in the performance of a complex skill from age two to age three may be largely due to improvement in Factor I, and that later gains are dependent in increasing degree upon Factor II, while still later Factor III comes in as the chief determinant of the higher levels of skill. However, such changes in factor-pattern as well as the changes in total performance on the task in question are, in all probability, gradual rather than saltatory. If this point of view is correct, it is logical to expect that the factor loadings for a series of tests given at annual intervals will change somewhat from one year to the next but that some relationship, though not necessarily a perfect one, will be maintained. Since, as far as the writers are aware, no one has previously subjected the factor analysis method to the test of comparing the loadings obtained for the same tests when applied to children of successive age-levels, it seems worth while to submit our findings in spite of the small number of cases at the two lower ages.

It will be seen from table 10 that there is a fair amount of consistency in the loadings for the first factor at all three ages. While the nature of the factors brought out in a factor analysis is of necessity a matter of logical inference rather than of statistical objectivity, the distribution of the loadings from one test to another suggests that the common factor is something analogous to general motor maturity. Since chronological age has been experimentally controlled within each group, individual differences in respect to this factor must be ascribed to a more rapid rate of motor development in some children than in others. The negative loading of the walking path test with this factor at the age of three is in accordance with the observation that the early stages of progress in this skill are marked by an increase, rather than a decrease, in the time required to perform the task. Among the children of four and five years, variations in time become of relatively little importance as indications of motor maturity, but are probably more nearly related to temperamental characteristics. The significant thing at these later ages is the number of errors made. The factor analysis is thus in accordance with the conclusions which might be directly arrived at by observation of children of different ages when performing the task, viz.: that over the age range included in this experiment, maturity of performance on the walking path is manifested first in a decreased speed of performance and later by a decrease in the number of errors.

The relative significance of the first factor shows a tendency to decrease with age in both tapping tests, the needle threading test, and the reaction-time test. This suggests that performance on these tasks is more definitely dependent on general motor maturity at the early ages than at the later ages, and that as age advances, specific factors play an increasingly greater part. This is equivalent to saying that the maturation curve for these functions is negatively accelerated. That this is true for the tapping test at least has been shown else-

where (2). The three-hole test, on the contrary, shows a maximum loading with Factor I at the age of four-and-a-half. The comparatively smaller loading at the age of three may reflect the influence of temperamental characteristics among the younger children, a number of whom found this test difficult and uninteresting and who therefore may have been less inclined to put forth their best efforts. While the slight falling off in the first factor loading for this test at the age of five may be a fluctuation of sampling, it is very possible that it marks the beginning of a negatively accelerated rate of maturation, comparable to that shown in the four tests previously mentioned.

Examination of the second factor loadings for the different tests suggests that this factor may best be described as attentiveness or carefulness. Moreover, since a number of the loadings for this factor approximate zero, it would appear to be more limited in its functioning than is the first factor. The second factor shows a small negative relationship to speed on the walking path at all ages which is in line with our tentative interpretation that carefulness or attentiveness is involved, as is also the high positive loading with fewness of errors at the age of four. It appears to exert a negative effect upon speed of tapping which accords with our observation that children who were over-meticulous about their manner of tapping were less likely to attain a high degree of speed. The positive second factor loading of the three-hole test and the needle threading test where close attention to the task in hand is needed is also in accordance with this hypothesis. Speed of reaction also shows a fairly high loading with this factor among the five year olds, but very little relationship to it at the earlier ages. The latter fact may be a fluctuation of sampling since the number of cases is small. On the whole, our interpretation of this factor seems to fit in with the test loadings reasonably well except for the negative loadings with fewness of errors on the walking path at ages three and five. These loadings are not large, however, and may be chance fluctuations from zero.

The analysis was carried out one step further to include a third factor, but the loadings were small and showed so little consistency from one age to another that it seemed probable that they were chiefly determined by chance. Had the number of cases at each age been large enough to reduce the probable errors of the intercorrelations to a neglible amount, it is likely that other factors could have been located.

In spite of our limited sampling we nevertheless feel that the data are worth presenting since they suggest the possibility of utilizing the multiple factor technique for arriving at a quantitative analysis of the qualitative changes in pattern of ability that are characteristic of the growth-process.

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Mental and Social Maturity in Relation to Certain Indicators of the Degree of Juvenile Delinquency

MERVIN A. DUREA

I

SCIENTIFIC evidence has tended to establish that intelligence and social factors each have an appreciable relationship to delinquent behavior. Research, such as that of Ackerson (1), denotes that in certain definite respects mental development is not without differential significance in the problem of juvenile misconduct. Reckless and Smith (6) point out the variety of angles from which the social backgrounds of delinquents have been studied effectively. In line with investigations of the relationship of intelligence and delinquency on the one hand and social factors and delinquency on the other two desiderata merit attention. First, most studies whether of intelligence or social factors have considered juvenile delinquency as a general form of behavior without reference to the fact that it is variable in its manifestations. Slawson (7) has departed from the rule by estimating the degree of delinquency in terms of the number of arrests and severity of penalty for each offense. Second, while considerable is known concerning the effect of family size, home relationships, community conditions, home conditions, and other such social elements on the problems of delinquency, the question of social development of the individual delinquent has received little or no consideration, due probably to a lack of adequate techniques. Recently, however, with the advent of Furfey's (4) work the possibility of measuring the social development of juvenile offenders has presented itself.

From the point of view of the foregoing considerations the present study is concerned with the following:

(a) the pointing out of criteria which appear to be "indicators" of the degree of juvenile delinquency;

(b) the determination of the relationship of mental and social maturity to these indicators.

II

In this investigation the cases of 305 delinquent boys from the Boys' Industrial School[1] located at Lancaster, Ohio, were used. All subjects were of the white race. Aside from racial grouping no attempt was made at selection for factors such as intelligence and life age. It is probable that the group represents a fairly representa-

[1] Subjects were obtained through the coöperation of Mr. A. R. Harsh, Superintendent and Mr. Eric Bell, Psychologist.

tive cross-section of delinquent boys *in general*.

On each subject an intelligence rating was obtained by means of the National Intelligence Test, Scale A. Developmental ratings were secured by the Furfey Scale for Developmental Age, employing the original form (4). Results from the application of these two techniques were studied in terms of the Intelligence Quotient (IQ) in the case of the former and Developmental Quotient (DQ) in the case of the latter.

As indicators of the seriousness of delinquent behavior three criteria were used:

(a) *Frequency* (F)—the total number of times a given subject has appeared in Juvenile Court.

(b) *Scale Values* (SV)—an application of the writer's (3) scaling method to the offenses committed by a given subject. The different forms of offense were listed, a weighted value was assigned to each and these values were totaled.

(c) *Number of Offenses* (NO)—the total number of different forms of offense which a given subject has committed.

A gist of a typical case will clarify the method:

Case R. N. Subject is 16 years 5 months of age. He has been delinquent for over four years, having first appeared in Juvenile Court when 12 years of age. He has appeared in Court on three occasions. Offenses committed include truancy from home, burglary, and stealing. Burglarized *two stores, stole $35 and food*, boarded away from home with the stolen money, truant from home for a long period. Mental age on the National Intelligence Test was 16 years 0 months, Intelligence Quotient 103. Developmental age by the Furfey Scale 18 years 1 month, Developmental Quotient 113.

The following are the indicators of the degree of juvenile delinquency in this case: $F = 3$, $SV = 86$, and $NO = 3$. Scale Value was obtained from the sum of the differential weightings assigned to incorrigibility, burglary, and stealing, the weights being 20, 39, and 27, respectively.[1] In deriving SV's and NO's no account has been taken of repeated offenses of the same general type. Although a subject may have committed two or more delinquent acts classifiable as incorrigibility only the *form* and not the *specific act itself* has been considered. It has been assumed that in so far as offenses committed by a given subject are indicative of the seriousness of his delinquent behavior, the general form rather than the specific act expressive of this form is the more significant for computing SV's and NO's. Thus, for example, though the subject cited (Case R.N.) had two specific acts of burglary recorded against him, only burglary as the form of delinquency has been taken into account.

III

It has been indicated that Intelligence Quotients have been used to show the relative standing of subjects in mental ability and Developmental Quotients[2] their rating by the develop-

[1] For a full account of the method for classifying delinquencies under fourteen heads with differential scale values for each form of offense see the writer's article (3).

[2] Developmental Quotient =
$$\frac{\text{Developmental Age}}{\text{Life Age}} \times 100.$$

mental scale. By following this procedure the factor of life age has been controlled. In those instances in which life ages exceeded 16 years the 16-year denominator has been employed in calculating both Intelligence Quotients and Developmental Quotients. Adoption of the 16-year standard was, of course, arbitrary, especially in computing Developmental Quotients. Recent work of Furfey (5), however, suggests the possibility of an upper-limit of 16 years in relation to normal social development. The 16-year standard appeared to be justified in calculating Intelligence Quotients from the National Intelligence Test since there is some question as to whether this instrument is psychometrically equivalent to the Stanford-Binet or other intelligence scales in connection with which a 14-year upper-limit is used at times.

Table 1 shows a frequency distribution of Intelligence Quotients based on the cases of 365 delinquent boys. As will be noted, the distribution approximates a normal probability curve. The mean Intelligence Quotient is 86.8, the AD 11.1.

The amount of mental retardation evidenced by the present group of delinquents compares favorably with that which has been found by other investigators. Burt (2) states that the "average mental ratio of the juvenile offender proves to be about 89 per cent." Slawson (7), utilizing both a 16-year and 14-year upper-limit, found Stanford-Binet Intelligence Quotients averaging 76.4 in the former case and 87.7 in the latter on a group of boys from the New York House of Refuge. It is probable that the mean IQ based on an upper-limit of 14 years is a more accurate measure of the mental status of delinquents since the Stanford-Binet was used. Ackerson (1) estimates the average Intelligence Quotient of both sexes to be between 75 and 80. Apparently two facts are implied by a study of the Intelligence Quotients of juvenile offenders: (a) as a group they are mentally retarded; and (b) their typical Intelligence Quotient is in the neighborhood of 80 to 85.

TABLE 1

Frequency distribution of Intelligence Quotients

Intelligence Quotients

	CLASS INTERVAL								TOTAL
	50–59	60–69	70–79	80–89	90–99	100–109	110–119	120–129	
Number of Cases............	2	30	97	68	92	64	11	1	365

Table 2 shows a frequency distribution of DQ's, the general tendency of which is likewise normal but with considerably more spread than in the distribution of Intelligence Quotients. The mean Developmental Quotient is 96.4, the AD 16.8. In so far as a Developmental Quotient of about 100 represents average social maturity, juvenile delinquents conform closely

to this standard. As a group, therefore, they are more mature socially than mentally since in comparison with an Intelligence Quotient of 100 the present group as well as others show a significant amount of retardation.

Referring again to indicators of the degree of delinquent behavior, Tables 3, 4, and 5 present frequency distributions of F, SV, and NO, respectively.

TABLE 2

Frequency distribution of Developmental Quotients

Developmental Quotient

	CLASS INTERVAL												TOTAL
	40–49	50–59	60–69	70–79	80–89	90–99	100–109	110–119	120–129	130–139	140–149	150–159	
Number of Cases..........	1	0	25	52	58	58	63	53	31	8	6	1	365

TABLE 3

Frequency distribution of F

Frequency of Court Appearance

	CLASS INTERVAL										TOTAL
	1	2	3	4	5	6	7	8	9	10 or more	
Number of Cases.........	29	57	75	42	39	34	22	11	19	37	365

TABLE 4

Frequency distribution of SV

Scale Values

	CLASS INTERVAL														TOTAL
	10–19	20–29	30–39	40–49	50–59	60–69	70–79	80–89	90–99	100–109	110–119	120–129	130–139	140–149 or more	
Number of Cases...	2	9	28	31	44	41	31	51	50	15	28	16	8	11	365

TABLE 5

Frequency distribution of NO

Number of offenses

	CLASS INTERVAL						TOTAL
	1	2	3	4	5	6	
Number of Cases.........	27	90	113	90	37	8	365

The mean of the distribution of F is 4.7, the AD 2.3. In general the measures are positively skewed.

The mean SV is 78.3, the average deviation of the array 24.8. Although somewhat irregular the distribution tends toward that of a normal frequency surface.

The mean NO is 3.1, the AD .94. It is noticeable that there is marked concentration of the cases. For example, more than 80 per cent of the

subjects fall within the class intervals 2, 3, and 4.

To point out the relationship between mental and social maturity and indicators of the extent of juvenile delinquency, two sets of tables have been constructed. Tables 6A, 6B, and 6C show, respectively, average Intelligence Quotients and Developmental Quotients for varying frequencies of appearance in Juvenile Court (F); for varying scale values (SV); and for differing numbers of offenses (NO). Tables 7A and 7B indicate, respectively, averages for F, SV, and NO in terms of different Intelligence Quotients and Developmental Quotients. The amount of deviation of each average from the mean of the distribution of the variable in question is shown in columns paralleling each series of averages and headed "Deviation." In interpreting relationships in the present connection a tenable hypothesis would seem to be that any considerable or marked divergence from the central tendency (mean) of a distribution would denote a tendency to relationship. For example, the mean Intelligence Quotient of 365 subjects as shown in Table 1 is 86.8. This may be regarded as a sort of *norm* with respect to which the series of mean IQ's in the following tables is compared. Any radical positive or negative departure from this norm would suggest relationship. The other series of means are interpreted in a similar manner.

An inspection of the foregoing three tables reveals little or nothing in the way of a tendency to relationship. It is obvious that both the Intelligence Quotients and Developmental Quotients are of comparative insignificance as differentiae of the variations occurring in the indicators, F, SV, and NO. With minor exceptions the series of mean Intelligence Quotients and mean Developmental Quotients cluster closely about the respective means of the distributions of these two measures. This is shown by the consistently small deviations and the averages of each column of deviations.

TABLE 6A

Relationship between frequency of court appearance and IQ and DQ

F	MEAN IQ	DEVIATION	MEAN DQ	DEVIATION
1	83.6	−3.2	97.4	+1.0
2	87.5	+.7	93.4	−3.0
3	88.5	+1.7	99.4	+3.0
4	86.0	−.8	93.8	−2.6
5	87.6	+.8	95.5	−.9
6	88.5	+1.7	96.2	−.2
7	87.3	+.5	97.3	+.9
8	85.9	−.9	105.0	+8.6
9	86.6	−.2	104.5	+8.1
10 or more	83.4	−3.4	91.2	−5.2
Average ...	....	1.39		3.35

N.B.: In computing averages for "Deviations" columns in the above and subsequent tables no account is taken of signs. The averages are not "average deviations" in the technical sense.

Based on the present analysis, if a given subject is moderate, average, or extreme in delinquent behavior, as estimated by the standards of seriousness herein employed, he is likely *on the average* to conform closely to the mean of the delinquent group in mental and social maturity.

When, as shown in Tables 7A and 7B, the means for F, SV, and NO are computed for varying levels of Intelli-

gence Quotients and Developmental Quotients the findings are substantially the same as have been mentioned

TABLE 6B

Relationship between scale values and IQ and DQ

SV	MEAN IQ	DEVIATION	MEAN DQ	DEVIATION
10–19	*		*	
20–29	78.6	−8.2	93.2	−3.2
30–39	86.4	−.4	94.3	−2.1
40–49	89.8	+3.0	91.1	−5.3
50–59	83.9	−2.9	95.0	−1.4
60–69	90.6	+3.8	99.4	+3.0
70–79	82.4	−4.4	92.1	−4.3
80–89	91.3	+4.5	100.0	+3.6
90–99	86.2	−.6	95.6	−.8
100–109	90.3	+3.5	101.7	+5.3
110–119	82.9	−3.9	97.1	+.7
120–129	85.6	−1.2	97.5	+1.1
130–139	82.5	−4.3	101.3	+4.9
140–149 or more	88.6	+1.8	99.5	+3.1
Average	....	3.27		2.98

* Small number of cases in class interval 10–19 grouped with those in adjacent class interval 20–29.

TABLE 6C

Relationship between number of offenses and IQ and DQ

NO	MEAN IQ	DEVIATION	MEAN DQ	DEVIATION
1	84.6	−2.2	96.5	+.1
2	88.2	+1.4	94.8	−1.6
3	86.7	−.1	96.0	−.4
4	86.7	−.1	98.6	+2.2
5	85.5	−1.3	96.1	−.3
6	86.3	−.5	98.8	+2.4
Average	....	.93		1.17

previously, namely, lack of relationship between mental and social maturity and indicators of the degree of juvenile delinquency. Any diver-

TABLE 7A

Relationship between IQ and F, SV, and NO

IQ	MEAN F	DEVIATION	MEAN SV	DEVIATION	MEAN NO	DEVIATION
50–59	*		*		*	
60–69	4.3	−.4	80.6	+2.3	3.3	+.2
70–79	5.1	+.4	78.1	−.2	3.1	.0
80–89	4.5	−.2	75.6	−2.7	3.0	−.1
90–99	5.0	+.3	83.1	+4.8	3.4	+.3
100–109	4.4	−.3	77.8	−.5	3.0	−.1
110–119	4.1	−.6	76.7	−1.6	3.0	−.1
120–129	**		**		**	
Average	.....	.72		2.02		.13

* Small number of cases in class interval 50–59 grouped with those in adjacent class interval 60–69.

** Small number of cases in class interval 120–129 grouped with those in adjacent class interval 110–119.

TABLE 7B

Relationship between DQ and F, SV, and NO

DQ	MEAN F	DEVIATION	MEAN SV	DEVIATION	MEAN NO	DEVIATION
40–49	*		*		*	
50–59	3.7	−1.0	72.0	−6.3	2.7	−.4
60–69	4.0	−.7	71.0	−7.3	3.0	−.1
70–79	5.3	+.6	78.5	+.2	3.3	+.2
80–89	4.9	+.2	75.3	−3.0	3.0	−.1
90–99	4.9	+.2	82.4	+4.1	3.3	+.2
100–109	4.6	−.1	79.0	+.7	3.0	−.1
110–119	4.6	−.1	74.4	−3.9	2.9	−.2
120–129	4.2	−.5	87.3	+9.0	3.3	+.2
130–139	4.3	−.4	75.0	−3.3	3.1	.0
140–149	6.3	−1.6	95.0	+16.7	3.9	+.8
150–159	**		**		**	
Average	.....	.54		5.45		.23

* Small number of cases in class interval 40–49 grouped with those in adjacent class interval 50–59.

** Small number of cases in class interval 150–159 grouped with those in adjacent class interval 140–149.

gence of the series of means for F, SV, and NO from the means of their respective distributions is for the most

part small. In brief, with increasing or decreasing intelligence or social maturity practically no clue is given as to whether or not a given individual is a major or minor offender.

IV

From this study the following general conclusions appear to be warranted:

1. As evidenced by the Intelligence Quotient the present group of delinquents is mentally retarded, the amount of retardation being consistent with findings by other investigators.

2. In terms of Developmental Quotient the group shows a higher average level of social than mental maturity.

3. Three indicators of the degree of juvenile delinquency have been proposed, namely, frequency of appearance in Juvenile Court (F), the sum of differential weights assigned to different types of offense (SV), and number of offenses committed (NO).

4. When a series of mean Intelligence Quotients and Developmental Quotients are computed for variations in F, SV, and NO, little or no relationship is ascertained.

5. When a series of means are computed for F, SV, and NO for variations in Intelligence Quotient and Developmental Quotient no appreciable relationship is observable.

6. In general, it may be stated, that mental and social maturity bear an insignificant relationship to indicators of the degree of delinquent behavior.

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Brief Reports

A Report of a Case of Inverted Writing and Drawing

WITHOUT attempting to theorize or draw any conclusions the writer would like to report a case of inverted writing and drawing. The child in question, whom we shall call Arthur, lives in Jefferson County, Kentucky between twelve and fifteen miles from the heart of Louisville. He is six years and ten months of age, chronologically. He tests on the Stanford Revision of the Binet-Simon Tests 78 months which gives him an Intelligence Quotient of .95. This Intelligence Quotient is probably somewhat low because of his lack of opportunity to learn. The child seems to be about average in his personality traits. His educational achievement, his emotional reactions, and his social behavior are all average or better. He is decidedly above the average of his own group.

The locality in which Arthur has lived is a very rough, hilly, and nonproductive agriculture section. Many of the people are engaged in moonshining and bootlegging. As a whole, they are very backward and densely ignorant. Though they live but a few miles from a large city, there are children in the grades who have never seen electric lights.

The family, which consists of the father, the mother, and five boys, is a typical mountaineer family. There are two boys older than Arthur, one twelve and the other nine, and two younger. The parents are in the early thirties. The father, who is now working on the CWA *relief work*, has been arrested at least twice for trafficking in illicit liquor. The parents attended a one room country school and have acquired an education equivalent to about six grades. The neighborhood now has a consolidated school under the county system.

Prior to entering school in September, 1934 Arthur had had no training in reading and practically none in writing. The only reading which the boy had heard was his mother reading occasionally from a newspaper and the oldest brother getting his lessons. Arthur had scribbled a little on a slate which hung on the wall but had made no attempt to write. He had practiced a little in copying numbers placed on the slate by the oldest brother. These were copied bottom-side up from the start. However, the boy was given very little attention in this direction before entering school. The teacher testifies that the boy had practically no skill in either writing or drawing when entering school.

Arthur has made normal progress in all of his school activities and is above the average of his own group. It was a number of days after Arthur entered school before the teacher discovered his peculiarity, of which he himself

was unaware. As soon as his attention was called to his peculiarity, he attempted to write rightside up. However, for the first three months when left alone he would do all of his work inverted. At the time the writer investigated this case, December 21, 1934 Arthur was making rapid improvement in correcting his difficulty. With a copy before him, he was writing correctly. When he had no copy he was in a state of doubt until after he got started. Frequently he would start writing upside down, then he would stop and erase and then continue writing correctly.

The writer's attention was first called to this case about the middle of November at which time he suggested to the teacher the following: Be patient and sympathetic with the child; do not make him over conscious of his peculiarity but merely call his attention to the correct way to write; and to keep a copy before him until he had reversed his writing. She has followed these instructions and the correction seems to be taking place normally and without any trouble developing. At his present rate of

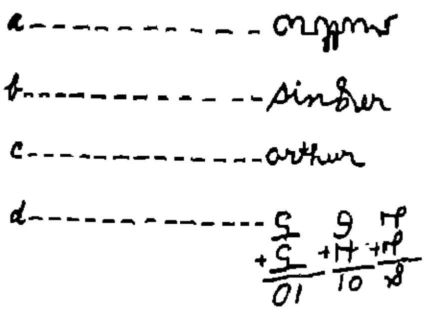

FIG. 1. SAMPLES OF WORK

a. Writing, first of November. *b*. last of November. *c*. December 21st. *d*. Number work.

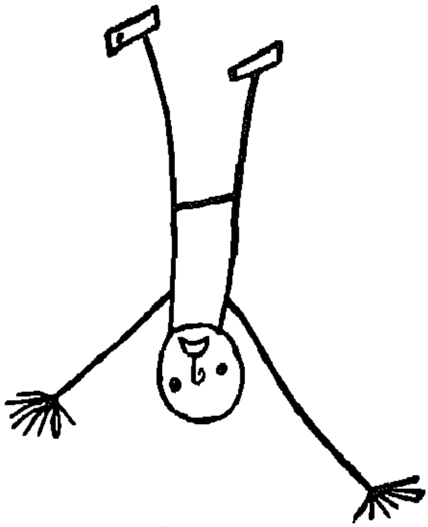

FIG. 2. SAMPLE OF DRAWING

improvement, his difficulty should be completely corrected in five or six months. Samples of his work are given in figures 1 and 2.

TESTS GIVEN AND RESULTS

(a) Visual acuity. The Lowell test and the Seitz test for children and illiterates were used. His vision was normal. The child had no difficulty in reading hand writing on the board from any position in the room.

(b) Intelligence test. He was given the Stanford Revision of the Binet-Simon Tests. This gave him an Intelligence Quotient of .95.

(c) Brain dominance:

1—Handedness:	Responses
Cutting with shears	R
Winding a spool	R
Throwing a ball	R
Batting with a club	R
Sweeping	R
Shoveling	R
Easy reaching	R

Energetic reaching............ R
Eating......................... R
Thumb up....................... R
Receiving...................... R
2—Footedness:
Standing on one foot........... R
Kicking........................ R
3—Earedness: Straining to listen... L
4—Eyedness: Paper-hole test (every time)........................... L

(d) Reading. The boy could read familiar material from his reading book as well bottomside up as rightside up. With new or less familiar words he preferred to have the book rightside up.

Summary

1—This child seems to be average in every way.

2—He is 82 months old with an IQ of .95.

3—He tests dominantly right handed.

4—He had had practically no training in writing or drawing prior to entering school. He has now had four months in school.

5—His first attempts in writing and drawing in school were inverted.

6—He is making steady improvement with the following treatment: The teacher is patient and sympathetic; she tries to keep him from being over conscious of his difficulty; and she encourages him to write from a copy.

7—No signs of stuttering or any other difficulty has appeared.

MARION LEROY BILLINGS

Unilateral Sighting Preference

IN AN analysis of 18 studies on ocular dominance which have appeared in the literature it was found that the percentage of right eyedness varied from fifty-five per cent to ninety per cent, left eyedness from six per cent to thirty-three per cent, and impartial eyedness from zero to twenty-six per cent. *It is the purpose of this article to present data which indicate that the variations are probably due to the criteria set up by the different investigators.*

In the present investigation a variety of commonly used unilateral sighting tests were used, such as pointing with the finger, sighting through a conical shaped tube, peeping through a hole, looking through a mailing tube, and sighting through a hole in a square piece of card board. The subjects were all elementary school children.

Thirteen opportunities were given for sighting with the conical tube, 6 opportunities by pointing, 3 with the square, 2 with the mailing tube, and 1 with the peep test. The abovementioned tests, together with several others of a similar nature, were then arranged in a battery so that a special group of subjects had 45 opportunities to make the unilateral sighting performance.

A subject was considered right eyed if he sighted invariably with the right eye regardless of the number of opportunities for sighting and left eyed if he sighted invariably with the left eye. Any variation from this consistency listed the subject as impartial eyed. This is wholly an arbitrary standard

but it is our opinion that the variations in the results of other investigators are due to the fact that they have not agreed upon such an arbitrary standard.

TABLE 1

The percentage of eye preference

NUMBER OF SIGHTINGS	NUMBER OF SUBJECTS	RIGHT EYE	LEFT EYE	IMPARTIAL EYE
		per cent	*per cent*	*per cent*
1	222	65.32	34.68	
2	538	62.49	30.85	6.66
3	784	61.61	33.16	5.23
6	786	57.40	29.72	12.88
13	730	46.68	20.58	32.74
45	113	38.05	12.40	49.55

It is seen from table 1 that as the number of opportunities for sighting increases and the criterion remains constant the percentage of eye preference varies. If only one opportunity is given all subjects must be either right eyed or left eyed. But with two or more opportunities impartial eyedness begins to appear. By increasing the opportunities indefinitely a point is eventually reached, theoretically, where all subjects would be impartial eyed.

In brief, any investigator can take any set of data and by varying the criterion of consistency can vary the percentage of eye preference. Consequently the data of no two investigators are comparable unless the number of sighting opportunities and the criterion are stated, and are in agreement.

Blake Crider

The Accuracy of Mothers' Reports on Birth and Developmental Data

M. K. PYLES, H. R. STOLZ AND J. W. MACFARLANE

THE present study aims to investigate the accuracy with which facts concerning children's early development are reported by mothers one to two years after the developmental period. No previous quantitative investigation of this problem has been made, although physicians, clinical psychologists, nursery school teachers (1, 6, 8) *et al.* currently depend upon the mothers' reports of the birth and early development of the children with whom they are concerned. Research workers have been interested in ascertaining information even more exact than that required by clinical workers on certain groups of children. Wilson and Jones (10), Carter (2), and others, used mothers' retrospective reports in considering intra-pair differences in twins on such items as "weight at birth," "length of pregnancy," etc. Terman's comparisons of the early development (prenatal and birth conditions, age of first tooth, and age of walking) of "gifted" children with a normal sample are based on mothers' reports (7). Another type of investigation in which mothers' reports are used, is the consideration of the prenatal and neonatal handicapping of the first born in relation to that for later births (4). Inasmuch as such extensive use has been made and probably will be made of such reports, a careful determination of their accuracy appears desirable. In addition, consideration should be given to the relation between the mother's intelligence or education and the accuracy of her reports, since several investigators have assumed this relationship to be positive (3, 7). Terman writes:

> "In judging the value of the information derived from parents, it is necessary to take account of the superior intelligence and education of the families represented in our group [of gifted children]."

A favorable opportunity to consider the accuracy of mothers' retrospective reports on developmental data is available in a cumulative study (5) made at the Institute of Child Welfare of the University of California. The 252 children included in this study are a representative sample, with respect to certain socio-economic factors, of the children living in Berkeley, California; since this group of 252 children is a representative sub-sample with respect to certain socio-economic factors (parents' nationality, income, father's occupation, socio-economic rating, neighborhood and mother's age and education) of the children included in the Berkeley Survey. The Berkeley Survey is comprised of every third

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child born in Berkeley over an eighteen-month period, 1928–1929 (9). The accuracy of mothers' later reports of their children's development was determined for this group, by comparing the mothers' reports when the children were aged 21 months with earlier records of the same developmental data.

The early or *primary records* are based on data obtained by the Institute's public health nurse (Miss Agnes Covalt) during the first year of the child's life. The primary data may be considered to have a high degree of accuracy and completeness since they were systematically taken at approximately the time of the event and involved checks through references to several sources of information (hospital, physician and mother). Soon after the children were born, circumnatal and pregnancy histories were obtained from attending physicians, hospital records, and mothers' own reports. Other primary data were secured by the nurse who visited each family at three-month intervals during the first year of the child's life and who recorded certain aspects of the child's development.

For purposes of comparison with the primary records, *later* reports of these same developmental items were obtained from the mother during the child's 21-month physical examination at the Institute. The questions were asked by the examining physician.

Items for which there are available both primary records and 21-month reports are:

Birth and maternity:
- (i) Physical condition of mother during pregnancy
- (ii) Duration of gestation
- (iii) Duration of labor
- (iv) Instruments at delivery
- (v) Injury to mother during delivery
- (vi) Weight at birth

Development during first year:
- (vii) Age walked alone
- (viii) Age first tooth appeared
- (ix) Weight at one year
- (x) Disease history during first year

AGREEMENT BETWEEN THE 21-MONTH REPORTS AND THE PRIMARY RECORDS

Several methods of comparing the 21-month reports and the primary records have been used because it was believed that the different methods offered supplementing information as to the agreement between the two sets of records.

In figure 1 the percentage of mothers whose reports are accurate (primary and 21-month reports are in exact agreement), is contrasted with (a) the percentage whose 21-month reports deviated by more or less than one standard deviation from the primary records (see table 1), and with (b) the percentage unable to recall these items when the children were aged 21 months. It may be seen that certain items such as "birthweight" and "duration of gestation" are accurately reported by a large percentage of the mothers; whereas "age at which child walked alone" and "age first tooth appeared" are *less* accurately reported; and "duration of labor" and "weight at 12 months" are least accurately reported. When the children were aged 21 months, as many as 65 per cent of the mothers were unable to make any statement about their children's 12-month weight.

Agreement coefficients, or the correlations between the 21-month reports and the primary records, are shown in table 1 (column 3). The item which is most accurately reported, with respect to the primary records, is the child's "weight at birth"; the correlation for this item is .96. Agreement coefficients for "age walked alone," "age first tooth appeared" and "weight at 12 months" are approximately .80. *It is interesting to note that the comparatively few mothers* (35 per cent of the cases) who are able to recall "weight at 12 months," report this item with a fair degree of accuracy. The item which is least accurately *reported is "duration of labor"; here* the correlation is only .61. The agreement between the primary records and the 21-month reports for "duration of labor" is probably low because of differences in the understanding of what constitutes "labor"; that is, whether one or all three stages should be included in the report of "duration of labor." On the whole, these correlation coefficients appear higher than might be expected from the percentage figures presented in figure 1. This suggests the inaccuracies which may be involved where agreement coefficients are as high as .80.

The differences between the means for the two sets of records are given in column 8 (table 1). These differences show whether or not there are definite tendencies for the mothers to *remember the children as heavier or* lighter than is indicated in the primary records; and whether the recall of such items as "age walked alone" and "age first tooth appeared" is in the direction of making the children *appear more precocious than is* suggested by the records obtained during the first year. The minus signs show that the mothers tend to underestimate the "duration of labor," "weight at birth" and "weight at 12 months," and to underestimate (thereby suggesting precocity) "age walked alone" and "age first tooth appeared." A further indication that mothers tend

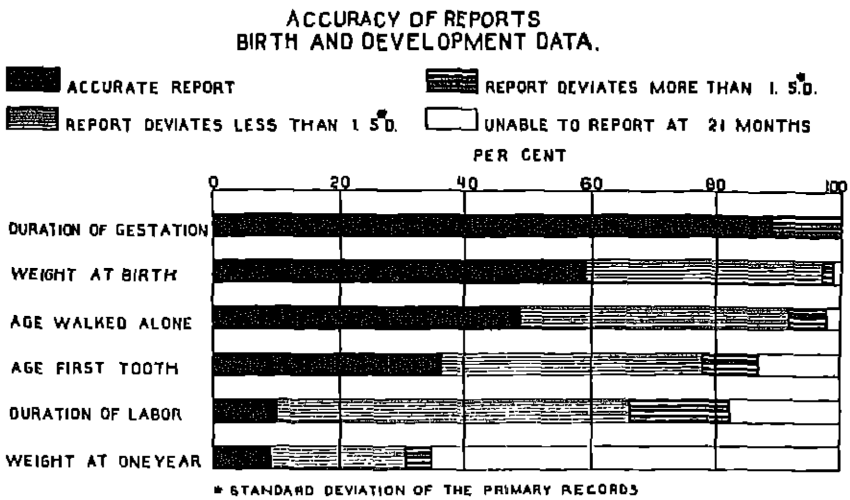

FIG. 1

to report in the direction of precocity for these latter two items is to be found in the comparison of the actual number of inaccurate reports which are overestimations (relative to the primary records) with the number which are underestimations. If there were no tendency for mothers to remember their children as more or less precocious, approximately 50 per cent of the inaccurate reports would be under- and 50 per cent would be to report their children as lighter or heavier at birth; 47 per cent and 53 per cent respectively over- and underestimated on this item.

Returning to the data presented in column 8 of table 1, it is found that the average distortion in the direction of precocity is .4 of a month for both "age child walked alone" and "age first tooth appeared." The reader may wonder at this point whether the mean difference of −.4 of a month (for "age

TABLE 1

Agreement between the 21-month reports of the children's development and the primary records

DEVELOPMENTAL ITEM	NUMBER OF CASES*	AGREEMENT COEFFICIENT	PRIMARY RECORDS		21-MONTH REPORTS		MEAN DIFFERENCE (DIFF. BETWEEN (6) AND (4))	ABSOLUTE DIFFERENCE (REGARDLESS OF DIRECTION)
			Mean	S.D.	Mean	S.D.		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		r						
Duration of labor (in hours).......	158	.61	8.57	5.28	8.23	5.74	−.34	3.5
Weight at birth (in ounces).......	223	.96	122.62	20.41	122.26	20.97	−.30	2.2
Weight at 12 months (in ounces)..	74	.79	367.74	40.10	358.82	48.52	−8.92	18.7
Age walked alone (in months).....	214	.84	13.68	2.16	13.29	2.20	−.39	.7
Age first tooth (in months)........	187	.80	7.71	2.08	7.30	2.19	−.41	.9

* The number of cases varies for the different items because a certain number of the mothers were unable to recall one or more of these facts at the 21-month interview.

overestimations. Actually, 75 per cent of the inaccurate reports for "age walked alone" and 72 per cent of the inaccurate reports for "age first tooth appeared," are in the direction of precocity (underestimations). That is, almost three times as many mothers erring on these two items, erred in the direction of making their children appear *more* precocious as erred in the direction of making their children appear *less* precocious. No systematic tendency was noted for mothers walked alone" and "month of first tooth") may not be due to a systematic tendency for mothers to report to the nearest month (*e.g.* 12.5 months reported simply as "12 months"). Examination of the data, however, reveals that although the majority of the discrepancies of one month or less were in the direction of suggesting precocity, an even larger proportion of discrepancies of *more* than one month were in this direction. In other words, whereas 27 mothers reported that their

children walked from 1.5 to 5 months *earlier* than the primary records suggest, only *8* mothers reported that their children walked from 1.5 to 5 months *later* than the primary records indicate. Similar results were obtained for "age of first tooth." Terman, comparing his "gifted" group with Mead's normal sample on "age of first walking," noted that on the average the "gifted" children walked about one month earlier than the normal children (7). Terman states that the data on the "gifted" group are "subject to the ordinary errors of report due to faults of memory and observation," but that "the coöperation of the parents was such that it is believed the question of intentional falsification of report need not be raised." It is not believed that there was intentional falsification in the 21-month reports in the present study, because of the mothers' coöperativeness and understanding that their reports were to be used only for research purposes. A slight tendency was noted for mothers who reported in the direction of precocity for one item to report in the *opposite* direction for the other item; the coefficient of contingency between the direction of the discrepancies for "age walked alone" and "age of first tooth" is −.17; or −.22 when corrected for broad categories. Although no systematic tendency was noted for mothers to report their children as heavier at birth and heavier at 12 months in the later reports, mothers who did report their children as heavier for one item tended to err in the same direction on the other item (coefficient of contingency +.26, or +.34 when corrected for broad categories).

In addition, table 1, column 9, presents the absolute differences or the *average discrepancies* (regardless of direction) between the primary records and the 21-month reports. The average discrepancies suggest the disagreement which might be expected for each item from individual mothers. The discrepancy to be expected on the average, in the 21-month report of "age of first tooth" is .9 of a month, and for "age walked alone" .7 of a month. The discrepancy in "birth-weight" of 2 ounces is of little significance; but in "duration of labor," the discrepancy of three and a half hours appears significantly large both clinically and statistically (see column 5).

The statistical methods used to indicate the agreement between the primary records and 21-month reports for the foregoing items were not applicable to the following: "physical condition of mother during pregnancy," "disease history during first year," "injury during delivery," "use of instruments at delivery." These four items have therefore been considered separately as follows.

Physical condition of mother during pregnancy

On the basis of the obstetrician's and hospital's records of the pre- and circumnatal conditions, the mother's "health during pregnancy" was rated by a physician (Herbert R. Stolz) as *either satisfactory or unsatisfactory.* Dr. Stolz's criterion in assigning these ratings was that the mother's condition was judged unsatisfactory if it were

such that it might have interfered with the normal development of the child (examples of unsatisfactory conditions are infected tonsils, thyroid enlargement, severe albuminuria, etc.).

The mothers' responses regarding their health during pregnancy, secured when their children were aged 21 months, fell quite readily into a 7-point scale ranging from "Very poor" to "Excellent." In table 2, the 21-month reports of the group of mothers whose physical condition was considered satisfactory (on the basis of physicians' and hospitals' records) are compared with the group whose physical condition was considered unsatisfactory. The biserial r between the early records and the 21-month reports is .22. It is of interest to note that of those mothers whose condition (according to the primary records) was unsatisfactory, as many reported that their health was "Excellent" or "Very good" as reported that their health was "Poor" or "Very poor."

TABLE 2

Physical condition of mother during pregnancy

Comparison of the 21-month reports for a group of mothers whose physical condition was considered *satisfactory* (according to the primary records), with a group whose physical condition was considered *unsatisfactory*

MOTHER'S REPORT WHEN CHILD AGED 21 MONTHS		PRIMARY RECORDS PHYSICIAN'S CLASSIFICATION					
		Satisfactory		Unsatisfactory		Total	
Rating		n	Per cent	n	Per cent	n	Per cent
7	"Excellent"	9	*5*	3	*7*	12	*5*
6	"Very Good"	30	*16*	6	*13*	36	*15*
5	"Good"	109	*57*	18	*39*	127	*53*
4	"Fairly Good"	14	*7*	4	*9*	18	*8*
3	"Not Well"	14	*7*	6	*13*	20	*8*
2	"Poor"	11	*6*	5	*11*	16	*7*
1	"Very Poor"	5	*3*	4	*9*	9	*4*
Total		192	101	46	101	238	100
Mean Rating		4.76		4.24		4.66	
S. D.		1.26		1.67		1.30	

Disease history during first year

The nurse who visited the families at 3-month intervals during the first year of the child's life, asked about the illnesses or handicaps that the child had experienced during the preceding three months. On the basis of the nurse's records, the disease history of the children during infancy was rated by Dr. Stolz on the following 5-point scale:

A rating of 5 was given to children who had suffered illnesses or physical handicap of such kind, frequency, severity, and duration as to justify the assumption that development was *markedly* modified thereby.

A rating of 4 was given to children who

had suffered illnesses or physical handicap of such kind, frequency, severity, and duration as to justify the assumption that development was *definitely* modified thereby

A rating of 3 was given to children who had suffered illnesses or physical handicap of such kind, frequency, severity, and duration as to justify the assumption that development was probably *slightly* modified thereby.

A rating of 2 was given to children who had suffered illnesses or physical handicap of such kind, frequency, severity, and duration as to be considered *insignificant* in relation to development.

A rating of 1 was given to children for whom no illness or physical handicap was reported.

When the children were aged 21 months, the physician who gave the physical examination at the Institute again asked the mothers about the children's illnesses during the first year. Table 3 presents the disease ratings for children whose mothers reported the occurrence of *some illness* and, in comparison, ratings of those children whose mothers reported the occurrence of *no illness* during the first year. The biserial r between the disease ratings and mothers' reports at 21 months is .62. It is encouraging to note that the mothers of all children whose disease records deserved a rating of 5 (having illness or physical handicaps of such kind, severity, frequency and duration as to justify the assumption that development was markedly modified thereby) reported the occurrence of at least *some illness* during the first year at the 21-month interview. On the other hand, at the 21-month interview the mothers of two children given ratings of 4,[1] and of twenty-eight children given ratings of 3 failed to report the occurrence of any illness during the first year.

TABLE 3

Disease rating during first year

Comparison of the disease ratings of the children whose mothers reported (at 21 months) some illness as having occurred during the first year, with those of children whose mothers reported no illness

DISEASE RATING (BASED ON NURSE'S RECORDS OF DISEASE HISTORY IN FIRST YEAR)	MOTHER'S REPORT AT 21 MONTHS					
	No illness		Some illness		Total	
	n	Per cent	n	Per cent	n	Per cent
5			8	*7*	8	*3*
4	2	*2*	19	*16*	21	*9*
3	28	*24*	53	*43*	81	*34*
2	57	*48*	42	*34*	99	*41*
1	31	*26*			31	*13*
Total..........	118	100	122	100	240	100
Mean Rating....	2.01		2.94		2.48	
S.D............	.75		.87		.94	

[1] The children given the ratings of 4 had respectively asthma and several colds, and whooping cough and eczema during the first year.

Instrumental delivery

Both primary records and the 21-month reports as to whether or not instruments were used in delivering the child, were available for 225[3] of the mothers. Fifty-four (or 24 per cent) of the 225 mothers were delivered with instruments. Comparison of the 21-month reports with the primary records shows that 67 per cent, or only *two-thirds*, of the 54 mothers delivered with instruments reported this fact at the 21-month interview. The reader may wonder, at this point, whether all of these 54 mothers were aware that instruments were used. It is quite possible that some were not; however, the fact still remains that a large number of mothers for whom there are primary records of the use of instruments failed to report this fact at a 21-month interview.

Injury to the mother at the birth of the child

Any laceration, tears or an episiotomy have been considered as injuries. The mothers' reports were frequently in the form of the number of stitches which had to be taken. According to the primary records, approximately two-thirds of the mothers were injured. When the children were aged 21 months, only 23 per cent of the mothers who were injured reported this fact.[2]

DISCUSSION

Because of the frequent visits and questionings of the Institute nurse, the mothers of the children included in this study were probably more conscious of their children's development than an entirely unselected group would be. For this reason, the agreement coefficients may appear too high. On the other hand, as has been mentioned, the mothers may not always have been informed of certain of the data in the primary records (health during pregnancy, use of instruments at delivery and injury during the birth of the child). There seems, however, to be no reason to expect that another group of mothers would be better informed than this one. It is interesting to note, in this connection, that in the group studied by Terman (7), *15 per cent* of the mothers of "gifted" children reported the use of instruments at delivery; this percentage is closer to the per cent obtained on the basis of the 21-month reports, *14 per cent*, than to the per cent based on the primary records, *24 per cent*.

A further point which might be mentioned is the apparent tendency for mothers to forget certain of the difficulties encountered with their children. Although *some* of the mothers may not have been aware that instruments were used or that they were injured during delivery, it seems unlikely that the number would be as great as is indicated in the 21-month reports. In other words, it would seem that there is a tendency for certain mothers to minimize or to unconsciously forget these difficulties. Other evidence for this tendency is to be noted in the number of illnesses had by the child during infancy which are *not* reported by the mothers at the 21-month interview. The forgetting of difficulties may be contrasted with

[3] This does not include cases where there was a Caesarean section.

the tendency to recall that the children "walked" or had their "first tooth" at an earlier age than the *primary records* indicate.

FACTORS RELATED TO ACCURACY OF REPORT

A consideration of practical and theoretical importance is the extent to which the *same* mothers give inaccurate reports on these different developmental items. If certain mothers consistently give accurate and other mothers consistently give inaccurate reports, the *intercorrelations of the discrepancies* between the primary records and the 21-month reports would be high. The intercorrelations for variables "month walked alone," "month first tooth," "birthweight," "weight at 12 months," and "duration of labor," were computed and found to range from $-.18$ to $+.27$. The highest correlations were obtained between the extent of the discrepancies in the reports of "age first tooth appeared" and "birthweight" (r .27), and "age first tooth appeared" and "age walked alone" (r .22). The intercorrelations in general are extremely low and approximate a zero relationship. Apparently within the range of ability considered in this study (a representative sample of mothers living in a moderately sized city), mothers show no general tendency to give accurate or widely discrepant reports on all items.

It seemed not unlikely that mothers *of several children* would have more difficulty than mothers of singletons in remembering the different aspects of their child's development. Correlations were therefore computed between the order of birth and discrepancies between the primary records *and the 21-month reports.* This analysis revealed a tendency for mothers of *several* children, in comparison with the mothers of singletons, to be *less accurate* (as evidenced by larger discrepancies) in their later reports of "weight at birth" (r .24) and "age of first tooth" (r .22). No relationship was found between birth order and inaccuracy of report on "age walked alone" (r .05), nor between birth order and inaccuracy of report on "duration of labor" (r .09). The relation between order of birth and accuracy of report on "birth weight" and "age of first tooth" may be attributable to the (a) lower intelligence of mothers of large families, or (b) confusion of data for different children. It appears that both these factors are operative. The correlation between the mother's education and birth order is $-.15$ (indicating lower intelligence of mothers of large families); and the correlation between mother's education and accuracy of report of "birth weight" tends to be positive (see next paragraph). These coefficients, however, do not entirely account for the relation between birth order and the discrepancies in the reports of "weight at birth" and "age of first tooth;" in other words, there is some evidence that mothers of several children tend to be less accurate in their later reports when the factor of education or intelligence is kept constant. A slightly greater tendency was observed for primiparae than for multiparae to err in the direction of precocity for "age walked alone" (78 per cent of the multiparae as compared with 71 per

cent of the primiparae) and "age first tooth appeared" (73 per cent as compared with 68 per cent).

The education of the mother, in terms of the number of years of schooling, was correlated with the accuracy (smallness of the discrepancy) for the different items. A correlation coefficient of .28 was obtained between mother's education and the accuracy of the report of "weight at birth." This correlation appears comparatively high in view of the large number of completely accurate reports for this item (fig. 1) and the restricted range of discrepancies. However, no relationship was found between mother's education and the accuracy of report on any other item. Ratings of the mother's intelligence were available for half of the sample (126 cases) included in the present study. Correlations between these ratings and the accuracy of reports tend to be similar to those obtained for mother's education. A positive correlation of .17 was found for the ratings of the mother's intelligence and the accuracy of report of the child's "birthweight."

The per cent of mothers unable to recall these developmental facts at 21 months is given in figure 1. It was thought possible that the less educated mothers might be able to recall fewer facts about their children's early development. A coefficient of contingency was therefore computed between fewness of years of schooling and the number of items on which mothers were "unable to recall" (a number of mothers were unable to recall as many as three of these items). This coefficient was found to be .28 (not corrected for broad categories), indicating a very slight degree of relationship.

SUMMARY AND CONCLUSIONS

1. In a representative sample of 252 children living in a superior urban community, comparisons were made between mothers' reports of their children's early development at a 21-month physical examination, and primary records taken during the first year. The agreement between the 21-month reports and the primary records may be summarized as follows:

Birth and maternity:

(i) *Physical condition of mother during pregnancy:* The biserial r between the 21-month reports and the primary records is .22, indicating extremely low agreement.

(ii) *Duration of gestation:* The 21-month reports and the primary records are in exact agreement for 89 per cent of this "normal sample" of mothers.

(iii) *Duration of labor:* The 21-month reports are in exact agreement with the primary records in only 10 per cent of the cases. The correlation between the two sets of records is .01 and the average discrepancy is 3.5 hours.

(iv) *Use of instruments at delivery:* Only two-thirds of the mothers who were delivered with instruments reported this fact at the 21-month interview.

(v) *Injury to mother during delivery:* Only 23 per cent of the mothers who were injured at the birth of the child reported this fact at the 21-month interview.

(vi) *Weight at birth:* The 21-month reports are in exact agreement with the primary records in 50 per cent of the cases; the corre-

lation between the two sets of records is .96 and the average discrepancy is approximately two ounces.

Development during first year:

(vii) *Age walked alone:* The 21-month reports of 49 per cent of the mothers are in exact agreement with the primary records; the correlation between these records is .84 and the average discrepancy .7 of a month.

(viii) *Age first tooth appeared:* This item is accurately reported by 36 per cent of the mothers; the correlation between the two sets of records is .80 and the average discrepancy .6 of a month.

(ix) *Weight at one year:* The 21-month reports of this weight are in exact agreement with the primary records in 0 per cent of the cases. Sixty-five per cent of the group were unable to recall this item at the 21-month interview. The average discrepancy, for those who were able to give information, was 10 ounces and the agreement coefficient .70.

(x) *Disease history during first year:* The biserial r between the child's disease ratings and the mother's reports at 21 months as to the occurrence of illness during the first year is .62.

In view of the following facts, these results are, if anything, rather too favorable as to the accuracy of mothers' reports, (a) although a representative sample of Berkeley, the sample is superior in education and intelligence to an unselected urban sample; (b) the group is more awake to developmental problems, more "child conscious" than ordinary groups because of the repeated visits of the nurse; (c) the later reports were obtained when the children were 21 months and *not*, as commonly, when the children are of school age or adolescent.

2. No general tendency was found for mothers to give either accurate or widely discrepant reports on *all* items.

3. Mothers tended to err in the direction of suggesting precocity in the 21-month reports of "age walked alone" and "age of first tooth."

4. A mother with several children shows a slightly greater tendency, on the average, to err than a mother with *only* one child, in reporting "birthweight" and "age of first tooth." Mothers of first-born children are more apt to err in the direction of suggesting precocity than are the mothers of later born.

5. A correlation of .28 was obtained between the accuracy of report of "weight at birth" and mother's education; and a coefficient of contingency of .28 was obtained between the number of items recalled at 21 months and mother's education. No other significant relation was found between either the intelligence ratings or education of the mothers and the accuracy of their reports.

6. The results show a slight but general tendency for mothers to forget some of the difficulties of rearing young children: mothers tend to forget the illnesses and disturbances suffered during pregnancy; they tend to forget the injuries received at the birth of the child and use of instruments at that time; slight illnesses of the child during infancy are forgotten; and finally, mothers tend to remember that their children walked and had their first teeth at an earlier age than the primary records indicate.

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A Research in Adolescence

I. Pubescence and Physical Growth

Hedley S. Dimock

THIS is the first of a series of articles which will report some of the most important findings of a research in which two hundred adolescents were studied continuously over a period of years. The findings around specific aspects of the adolescent's growth, attitudes, and behavior are significant in themselves. When put together, the results of the study strongly suggest the need for a new formulation of adolescent psychology based on the facts yielded by investigations which employ the best accredited methods and techniques of current scientific procedure.

Some of the problems on which data are to be presented in this first article have received the attention of other studies. The results of this study merit report, however, if for no other purpose than to serve as a basis of comparison between the amount and the rate of change in physical aspects of growth and of change in personality and behavior factors during adolescence. Some of the findings, as those on the relation between motor coördination and pubescence, for example, rather definitely challenge, if they do not controvert, popular conceptions—as in this case, that of "adolescent awkwardness."

A brief general description of the investigation will provide a background against which the findings to be reported in this and the following articles may be understood, and interpreted more intelligently. The most salient facts about the study can be stated in summary fashion.

1. It is a study of "normal" boys, that is, of the every-day boy who is being dealt with by parents and by public schools and other social agencies.

2. It is a continuous study of the same two hundred boys over a period of years.

3. It employed a combination of techniques to yield data concerning physiological, physical, personality, and social factors and their interrelationships.

4. It used existing standard testing procedures in the main but developed a few new techniques, including a "friendship finder" for studying quantitatively the interaction of individuals within a group or social situation.[1]

PUBESCENCE AND GROWTH IN HEIGHT AND WEIGHT

That physical growth of many kinds is accelerated during pubescence is a

[1] The series of articles to appear in *Child Development* will report those findings of the total study which the editors have considered to be of particular significance for readers of this journal.

well established and commonly known fact. Studies are plentiful which show the spurt in height, weight, strength, chest circumference, vital capacity, and similar factors during the adolescent years. Practically all of these reports, however, merely show the increase in height, weight, etc., with age, and *infer the presence of puberty from the observed acceleration in growth.* These investigations find that the maximum growth of boys in height, for example, is around the fourteenth year. It is then assumed, since other studies have reported this to be the average age of puberty, that the rapidity of growth is to be associated with pubescent development.

Since the age at which boys reach pubescence varies greatly—from eleven to sixteen years for the boys in this study,—it is obvious that such data do not *disclose the precise relation between pubescent change and physical growth.* We shall present here findings of the following three kinds, all of which are definitely related to this specific problem.

1. A comparison of the height and weight of boys of the same chronological age but in different stages of pubescent development, namely, prepubescence, pubescence, and postpubescence. These findings indicate that *pubescent age, or status, is more important than chronological age in determining the individual's height and weight.*

2. A comparison of the amount of growth in height and weight for a one- and a two-year period for boys in different stages of pubescent development.

3. Facts which indicate the relation between the age at which a boy reaches puberty and the rate of his subsequent growth.

The measurements, tests, and examinations which yielded the data presented in this article were administered annually for three successive years. The measurement procedure followed those described by C. K. Taylor in *Physical Standards for Boys and Girls.*

To determine the pubescent status of the boy the criteria most commonly employed in other reported studies of pubescence were used. These criteria, frequently called the "Crampton criteria" because of the pioneer study conducted by Crampton early in the century, are as follows: (*a*) Prepubescence is the total period of life before there are any physiological signs of puberty; (*b*) pubescence is marked by the appearance of pigmented hairs in the pubic region; (*c*) post-pubescence is marked by a kink or twist in the pubic hair and a wrinkled scrotum (4).

These criteria are not so reliable in determining the pubescent status of a boy as would be the date of the first nocturnal emission, or microscopic evidence of the first secretion of spermatozoa. The latter method for ascertaining the pubescent status of boys was employed by Baldwin (1). Crampton (4) validated the criteria he employed, however, by some microscopic examinations of secretions and "in every case well formed and mobile spermatozoa made their appearance in the months of transition to postpubescence." In a recent study by West (7) at Springfield, Mass., it was demonstrated rather clearly that the pubic index is more reliable than either the axillary or mammary in

ascertaining the pubescent status of boys (7).

Height and weight in relation to pubescent status

The facts reported in figure 1 provide a comparison of the mean height measures of pre-pubescent, pubescent, and post-pubescent boys at various chronological ages. Figure 2 presents similar data for the weight measures.

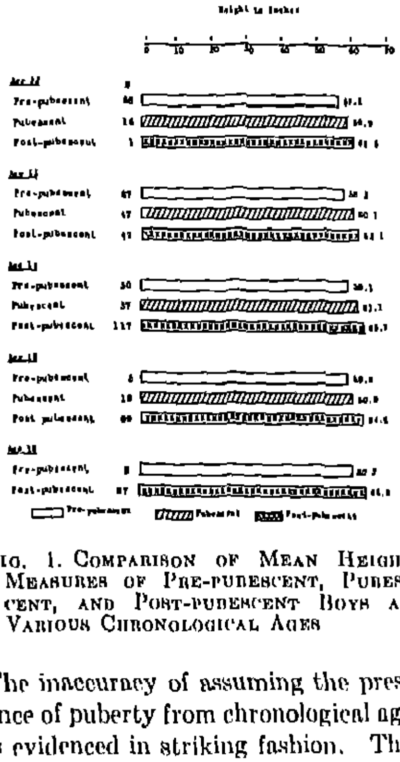


FIG. 1. COMPARISON OF MEAN HEIGHT MEASURES OF PRE-PUBESCENT, PUBESCENT, AND POST-PUBESCENT BOYS AT VARIOUS CHRONOLOGICAL AGES

The inaccuracy of assuming the presence of puberty from chronological age is evidenced in striking fashion. The impossibility of predicting or inferring physical growth from chronological age is also conspicuously apparent.

The foregoing figures indicate that the pubescent boy at twelve or thirteen is likely to be both taller and heavier than the boy two years older who is still pre-pubescent. The average age of the boys in each of the 3 pubescent classes in each chronological age group is approximately the same. The post-pubescents average about one-half month older than the pre-pubescents. The differences in height and weight which accompany different stages of growth are marked in the fourteen- and fifteen-year-old groups. At fourteen the post-pubescent boy exceeds the pre-pubescent of the same chrono-

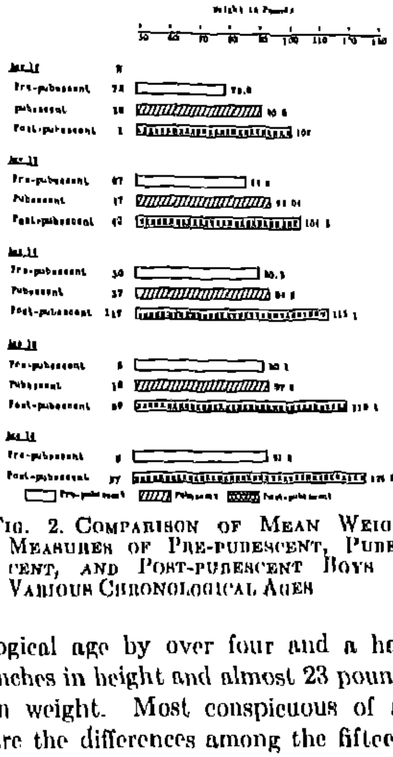


FIG. 2. COMPARISON OF MEAN WEIGHT MEASURES OF PRE-PUBESCENT, PUBESCENT, AND POST-PUBESCENT BOYS AT VARIOUS CHRONOLOGICAL AGES

logical age by over four and a half inches in height and almost 23 pounds in weight. Most conspicuous of all are the differences among the fifteen-year-olds. Even though the number of pre-pubescents is small here the data for the pubescent boys bring support to their creditability. The post-pubescent boy at fifteen, on the average, is 5 inches taller and 20 pounds heavier than the boy of the same age who is not yet pubescent.

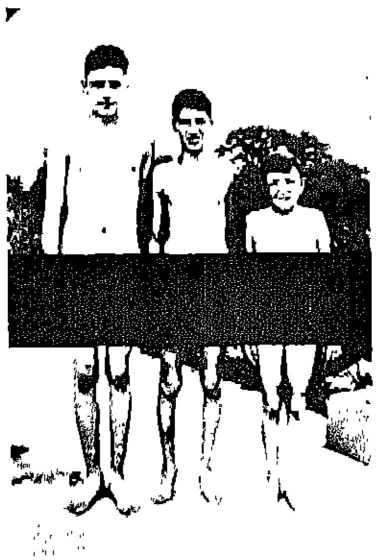
As will be shown later, this difference is not due entirely to pubescent change. It may be concluded that the chronological age of a boy tells little about his physical status. In fact, it may tend to be misleading, because of the popular tendency to assume that a boy is pubescent at a certain age and then to make judgments about him based on this precarious assumption.

1. Boys who remain pre-pubescent for the period, the symbol for which is P_{1-1}.

2. Boys who change from pre-pubescence to pubescence during the period, the symbol for which is P_{1-2}.

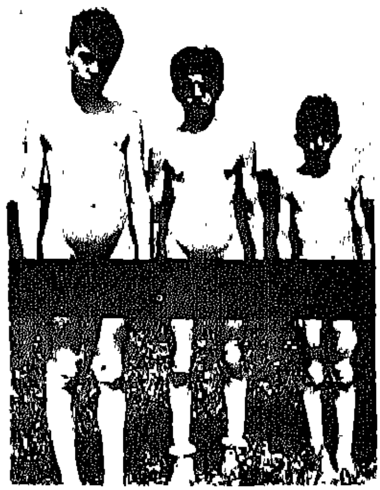
3. Boys who are pubescent at the beginning and the end of the period, the symbol for which is P_{2-2}.

4. Boys who change from pre-



A CONCRETE ILLUSTRATION OF THE FINDINGS SHOWN IN FIGURES 1 AND 2

These boys are all fifteen years of age but are in different stages of pubescent growth. The boy on the left is post-pubescent (P_3); the one in the middle pubescent (P_2), and the one at the right is pre-pubescent (P_1).



ANOTHER ILLUSTRATION OF THE FINDINGS PRESENTED IN FIGURES 1 AND 2

The chronological ages of the boys are in inverse order to their physical size. The boy at the left is 13 years and 1 month old, and post-pubescent (P_3); the boy in the middle is 13 years and five months old, and is pubescent (P_2). The boy at the right is 14 years and 6 months of age, and is pre-pubescent (P_1).

Growth in height and weight in relation to pubescent change. We next present the materials which show more definitely the differences in the amount of growth which accompany different stages of pubescent status and change during a one- and two-year period. There are 6 groups or classifications of pubescent status and change:

pubescence to post-pubescence within the period, the symbol for which is P_{1-3}.

5. Boys who change from pubescence to post-pubescence within the period, the symbol for which is P_{2-3}.

6. Boys who are post-pubescent at the beginning and the end of the period, the symbol for which is P_{3-3}.

The increase in height and weight for one year's growth that accompanies the different stages of pubescent status and development is reported in figures 3 and 4. The average growth for boys from twelve to fifteen years of age who remain pre-pubescent for a year is 1.8 inches and 7.6 pounds. This is the smallest amount of growth for any of the six possibilities in the pubescent development portrayed by the figures. The change from pre-pubescence to pubescence (P_{1-2}) during the year resulted in the second smallest amount of growth for both height and weight. The most rapid physical growth comes during the shift from pubescence to post-puberty (P_{2-3}). During the year the boy enters post-pubescence he puts on twice as much weight and increases almost twice as much in height as the boy who remains pre-pubescent for a similar period.

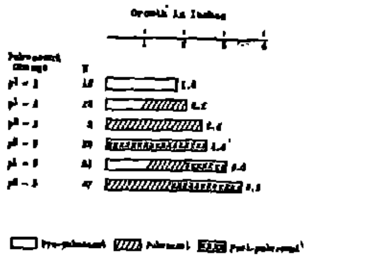


FIG. 3. INCREASE IN HEIGHT FOR ONE YEAR WITH PUBESCENT CHANGE

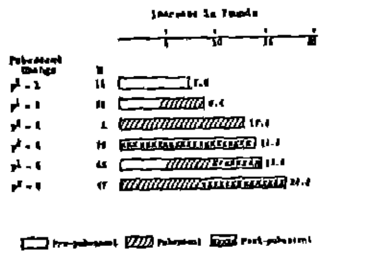


FIG. 4. INCREASE IN WEIGHT FOR ONE YEAR WITH PUBESCENT CHANGE

The cases of boys who remain pubescent for a year (P_{2-2}) without reaching post-pubescence are few, but they do suggest that an acceleration of growth accompanies pubescence even though post-puberty is not achieved within the year. It should be noted that only 15 per cent of the pubescent (P_2) cases remain in that stage for a year. The growth that follows post-puberty averages a little more than that for boys who remain pubescent.

The fact that change from pre-pubescence through puberty into post-pubescence (P_{1-3}) in a year does not result in quite as much increase in height and weight as does the shift from pubescence to post-puberty (P_{2-3}) in the same length of time seems to call for interpretation. The reason for this can be understood by noting that growth in the P_{1-1} period is less rapid than for any stage after pubescence has been attained. Part of the time, therefore, the growth of the boy who travels the range from pre-pubescence to post-puberty within a year is taking place at the least rapid rate. An examination of facts not reported here shows, further, that the growth of the boys who passed from pre-puberty to post-pubescence in a year was more rapid in both height and weight in the subsequent year than that of the boys in the P_{2-3} category. We interpret this to mean that the period which immediately precedes and follows the attainment of post-pubescence is accompanied by rapid growth.

Figures 5 and 6 display graphically the findings on two years growth in

height and weight in relation to pubescent status.

These data provide some additional knowledge of the relation between pubescence and growth rates. The boys who remain pre-pubescent for two years still show the least gain in weight but those who have reached the post-pubescent stage have the least gain in height; probably the differences are not significant, however, between the P_{3-3} and the P_{1-1} cases. If these differences were significant, they would suggest that acceleration of growth in weight tends to continue longer than acceleration of growth in height.

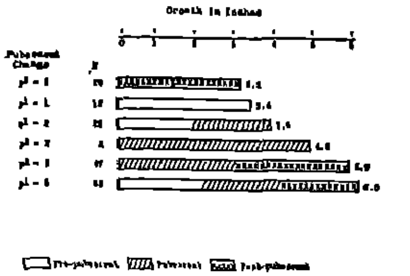


FIG. 5. AMOUNT OF GROWTH IN HEIGHT FOR TWO YEARS WITH PUBESCENT CHANGE

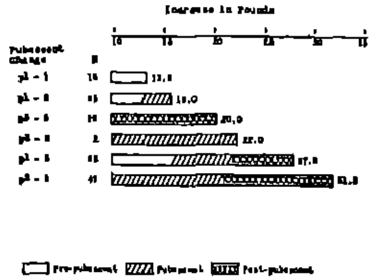


FIG. 6. AMOUNT OF GROWTH IN WEIGHT FOR TWO YEARS WITH PUBESCENT CHANGE

pubescence is not far away. The boys who change from either pre-pubescence or puberty to post-pubescence during the two years more than double the weight increase of those who do not reach puberty. The increase in height for these boys in two years, as for the one-year period, is not quite twice as much as it is for those who remain pre-pubescent.

All of these findings are based on averages and tend to obscure the individual variations from these averages, which, of course, are very important. We have been looking for generalizations about the trend, however, and on that basis only is there justification for depending entirely on averages in making this report.

There are only 2 cases of boys who remain in the pubescent status for two years; consequently, any conclusion made would be precarious. Their growth in height and weight happens to be greater than that for the boys who are either pre-pubescent or post-pubescent for the two years. This seems to be consistent with the other findings, which imply that the least growth takes place in the pre-pubescent stage and the most rapid growth during the transition from pubescence to post-pubescence. It might be a fair "guess" that since these boys have been pubescent for two years post-

Pubescence and per cent increase in height and weight. The foregoing data and discussion are based on actual increments of growth in height or weight without taking account of the size of the boys at the time of their first measurement. Some students of physical growth problems believe that the rate of growth is most accurately ascertained when the calculations represent the per cent of gain over the original measurement. We have treated our height and weight data for

the one-year growth period in this way. The results may be scrutinized in table 1 and figure 7. They indicate that the 6 pubescent categories have about the same relative significance for growth whether the growth measures are based on actual increments or per cent of increase. What stands growth that accompanies a particular shift in pubescent status is relatively constant regardless of the age of the boy. The number of cases in the study, when spread over the 6 possible pubescent categories for each chronological age from twelve to sixteen, is small, so we must depend largely upon

TABLE 1

Per cent increase in height and weight for one year with pubescent change

PUBESCENT CHANGE	N	HEIGHT			WEIGHT		
		Mean in inches	Mean gain	Per cent gain	Mean in pounds	Mean gain	Per cent gain
P_{1-1}	54	57.0	1.8	3.1	80.0	6.0	7.5
P_{1-2}	43	57.7	2.2	3.8	80.9	8.5	10.5
P_{1-3}	38	58.3	3.0	5.1	85.0	13.6	15.8
P_{2-2}	14	59.4	2.6	4.4	84.8	11.7	13.8
P_{2-3}	63	60.1	3.3	5.5	92.2	16.4	17.8
P_{3-3}	118	63.0	2.4	3.8	110.6	13.2	11.9

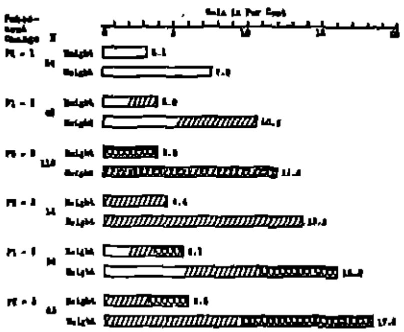


FIG. 7. PER CENT INCREASE IN HEIGHT AND WEIGHT FOR 1 YEAR WITH PUBESCENT CHANGE

out most conspicuously when figure 7 is examined is that the growth in weight is nearly three times as fast as that in height when calculated on the basis of per cent of increase.

INFLUENCE OF AGE ON PHYSICAL GROWTH

We next come to the question of whether or not the amount of physical the consistency of the results for our judgments as to their dependability. Our findings bearing upon this problem have been organized in figures 8 and 9.

We may swiftly summarize the conclusions which the facts reported by figures 8 and 9 suggest. Growth in height and in weight is approximately the same for the twelve- and the thirteen-year-old pre-pubescent boy. It probably tends to become less as a boy becomes older if he remains pre-pubescent. That is about all that can be assumed in view of the small number of cases in the fourteen- and fifteen-year-old groups. The shift from pre-pubescence to puberty evidently brings a slower growth in both height and weight for the boy at twelve than for the thirteen- and fourteen-year-old boy. The growth figures are 1.8, 2.4, and 2.2 inches and 7.2, 9.0, and 8.3 pounds, respectively, for a

year. The number of boys who stayed in the pubescent class for a year with no physiological change is too small to warrant conclusions, but it may be noted that the increase in height and weight is greater than where the boy remains pre-pubescent or shifts from pre-pubescence to puberty. The amount of growth that accompanies the change from P_2 to P_3 is approximately the same for twelve-, thirteen-, and fourteen-year olds, the amounts being 3.1, 3.4, and 3.2 inches and 15.8, 17.4, and 15.6 pounds, in this order. These findings are at variance with the conclusions of other investigators to the effect that growth is more rapid and intense when pubescence is attained early.

There is apparently, however, a tendency for the older boys to gain less in height than the twelve-year-old group when the shift from pre-pubescence to post-pubescence takes place in a year. The amount drops consistently, running 3.3, 2.9, and 2.5 inches for the twelve-, the thirteen-, and the fourteen-year-old classes, respectively. The older boys apparently compensate for this smaller gain by maintaining a higher growth rate in the following two or three years. The evidence for this is not included in this report. Our findings are similar to those secured in a much more exhaustive study on this point reported by Boas (2). The age at which the growth spurt comes does not materially affect adult stature; that is, the growth curve tends to flatten out sooner when acceleration is early than when it comes later in adolescence. The tendency in the weight data reverses

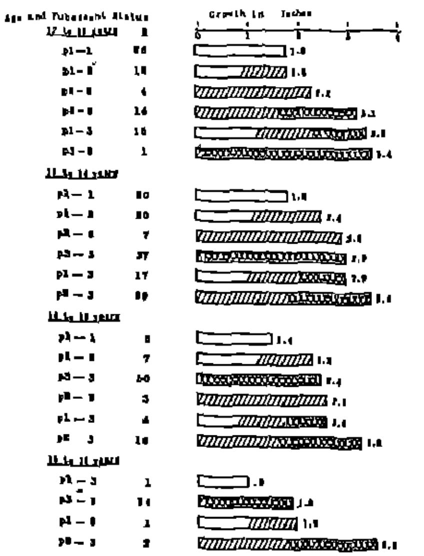


FIG. 8. GROWTH IN HEIGHT FOR 1 YEAR WITH PUBESCENT CHANGE FOR BOYS OF DIFFERENT CHRONOLOGICAL AGES

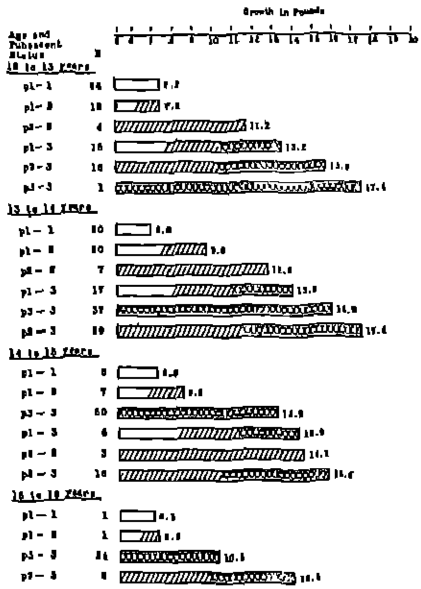


FIG. 9. GROWTH IN WEIGHT FOR 1 YEAR WITH PUBESCENT CHANGE FOR BOYS OF DIFFERENT CHRONOLOGICAL AGES

that of the findings on height. The increments of gain in weight for the transition from pre-pubescence to post-pubescence are slightly larger.

Evidence from correlations

Table 2 presents correlations of pubescent status and of chronological age with height and weight. The correlations are smaller than they would be if the cases were less homogenous. If the age span were five to twenty, for example, instead of twelve to sixteen, the resulting correlations would probably be considerably higher. It will be observed that pubescent status correlates more highly with height and weight than does chronological age. The formula used for the correlations of pubescent status with the other measures was suitable for the correlations of a qualitative with a quantitative series (5). Partial correlations are considered by some of our statisticians to be very precarious but with this caution they are also shown in table 2. If dependable, the association between pubescence and height and weight stands out a little more clearly.

In view of the facts displayed in figures 1 and 2, a greater discrepancy between the correlations of pubescence and of chronological age with height and weight would be expected. The explanation of this situation seems to lie, in part, in the fact that the height and weight measures represent the total growth (or life span) of the individual at the time of measurement rather than merely the amount of growth for a one- or a two-year period within which differences accompanying pubescent development show up more sharply. This can be made more concrete by illustration. Let us assume that 2 pre-pubescent boys are 60 inches tall at 13, and that one becomes post-pubescent while the other remains pre-pubescent during the following year, with a corresponding growth of 4 and 1.5 inches, respectively. The growth differences are relatively great, but the difference between 64 and 61.5 is not nearly as substantial. It is this second kind of difference, however, which shows up in these correlations. The association between actual growth measures and pubescent change would be much greater.

TABLE 2

Correlations of pubescent status and chronological age with height and weight

	r
Pubescent status and height	.54
Pubescent status and weight	.55
Age and height	.51
Age and weight	.52
Pubescent status and height, with age constant	.37
Pubescent status and weight, with age constant	.39
Age and height, with pubescent status constant	.32
Age and weight, with pubescent status constant	.32

SUMMARY OF CONCLUSIONS

From the foregoing findings the following conclusions may be summarized:

1. *Pubescent status cannot be inferred from chronological age.* The chronological age of the individual during the "adolescent" years is not a trustworthy index of pubescent status.

2. The differences in the height and weight of boys of the same chronological age but of different pubescent status are approximately as great as those between boys two years different in age but of the same pubescent status.

3. The most rapid growth in height and weight comes in the year during which the boy passes from pubescence to post-pubescence. This is true whether actual growth or per cent increase measures are employed. It also tends to be true regardless of age within the range of thirteen to fifteen.

STRENGTH AND MOTOR ABILITY IN RELATION TO PUBESCENCE

All sorts of notions have been current concerning the physical capacity and the motor coördination of the adolescent boy. A frequent assertion is that the strength of the rapidly-growing adolescent is not commensurate with the new proportions of his physical stature. Some writers assert that although the maximum strength may be there potentially the point of fatigue is likely to be quickly reached. A rather common explanation of "laziness" in the adolescent boy is in terms of an enlarging physical frame not yet come under adequate muscular and nervous control. What is perhaps the most common stereotype is the assumption that physical awkwardness and clumsiness are characteristic of the swiftly-growing adolescent. Because his bone structure and frame have outgrown his muscular control he has been described by many writers as being like a person "walking on stilts."

The question of the accuracy of these popular conceptions was only a secondary consideration, however, in the employment of a battery of physical strength, or capacity, tests and a battery of motor coördination tests in the annual physical measurement of the boys in this study. Evidence as to their trustworthiness was secured incidentally as data concerning such basic concerns as the following were being secured: the rate of development in physical strength and motor ability during adolescence; the relation of these two elements to pubescent development as well as to chronological age; the relation between growth in such elements as height and weight and the accompanying changes in physical capacity and motor ability.

First, we shall review the findings yielded by the physical capacity tests. Then we shall present a rather comprehensive set of facts concerning motor ability in relation to pubescent and physical development.

Pubescence and strength

The tests used for the measurement of physical strength were those standardized by Rogers (6). In order that the reader may clearly understand the kind and extent of physical strength, or capacity, which was being measured, it is desirable to describe the tests and their method of scoring. There were 7 tests, involving the use of 5 pieces of apparatus designed to measure vital capacity and the strength of the larger muscles. The factors tested and the tests used were:

1. *Lung or breathing capacity*, commonly termed vital capacity, measured

with a spirometer. Each boy had 2 trials, the better of the 2 being recorded in cubic inches.

2 and 3. *Strength of grip*, or forearm, of both right and left hands, was measured by squeezing a hand-dynamometer. The best achievement for the two attempts with each hand was recorded in pounds.

4. *Strength of back* was measured by the number of pounds that could be lifted by the back muscles as registered on a back and leg dynamometer (frequently styled a "back and leg lift machine"). Only one trial was given, since it has been demonstrated that the maximum lift is generally the first one.

5. *Strength of legs* was measured by lifting with the leg muscles on the back and leg dynamometer, carrying the weight on the thighs. This score also was recorded in pounds.

6. *Strength of arms and shoulder girdle, in extension*, was measured by the number of "push-ups" the boy could accomplish from a prone position on the parallel bars.

7. *Strength of arms and shoulder girdle, in flexion*, was measured by the number of "pull-ups" or "chinnings" the boy could do, holding eight-inch rings suspended from an overhead ladder. Since weight and height are conditioning factors in both "push-ups" and "pull-ups," the scores for these two tests took these factors into account.

This battery of tests yields a measurement or appraisal of a boy's vital capacity and of the strength of his grip, arms, shoulders, legs, and back. Some of the events required merely a maximum single effort, such as the back and leg lift tests; others, such as "the chinning" and "the push-ups," involved the elements of endurance and fatigue.

TABLE 3

Physical capacity measures of 553 boys by average age

	AVERAGE AGE					PER CENT INCREASE
	12	13	14	15	16	
	N					
	88	155	179	105	26	
Total physical capacity scores	660	807	980	1130	1241	88
Vital capacity	150	175	200	223	240	60
Strength of back	163	176	204	227	253	55
Pull-ups	1.1	2.7	3.0	4.8	5.5	400

The scores on all of these 7 tests were combined to form a single measure, or index, of physical capacity, or strength. The elements which enter into this total score will need to be kept in mind, as the combined score rather than individual scores will be used in reporting the results. It may give further meaning to this physical capacity score if we add that Rogers found a substantial correlation, an r of .81 between the physical capacity

score and an athletic index based on the achievement of high school students in standard athletic events.

The increase of strength with chronological age as measured by these seven tests is exhibited in table 3. The total score jumped from 666 for twelve-year-old boys to 1241 for sixteen-year olds, an increase of 86 per cent. In no other physical measure was the growth as rapid for this four-year period. It will be observed from table 3 that the rate of increase varied greatly with the specific tests which entered into the total measure. Strength of back, for example, as measured by the amount lifted with the back on the back and leg dynamometer showed an increase of 55 per cent. In the "pull-ups" or "chinnings," the sixteen-year-old boy does 5 times the number of the twelve-year olds, an increase of 400 per cent.

While the precise relationship of physical capacity with pubescent development is not revealed by these data, it can be concluded, since most of the twelve-year-old boys are pre-pubescent and practically all of the sixteen-year olds are post-pubescent, that physical strength is almost doubled in the four-year span during which most boys shift from pre-puberty to post-puberty. The correlation of physical capacity with age is .59, which is higher than that of age with height or weight.

Strength in relation to pubescent status and change. The scores of the boys for the three annual tests in physical strength according to age and pubescent status are given in figure 10. Comparison with figures 1 and 2, showing similar data on height and weight, are valuable here. The post-pubescent boy at 13 is stronger, as well as taller and heavier, than the pre-pubescent two years older. But the pubescent boy at 12 and 13 does not show the superiority in physical capacity over the pre-pubescent boy two years older as he does in height and weight. This fact suggests the hypothesis,° which other data will bear upon more directly, that acceleration

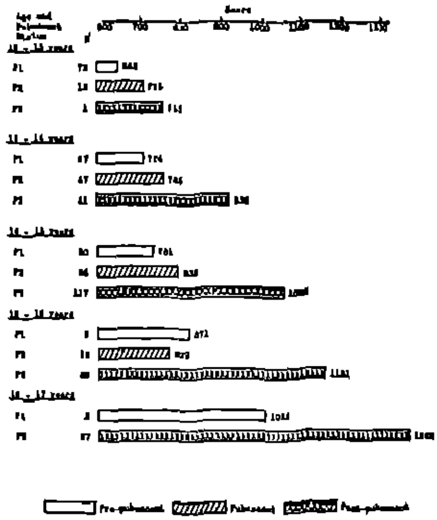


FIG. 10. COMPARISON OF PHYSICAL CAPACITY SCORES OF PRE-PUBESCENT, PUBESCENT, AND POST-PUBESCENT BOYS AT VARIOUS CHRONOLOGICAL AGES

in physical strength lags somewhat behind the spurt of growth in height and weight.

Increase in strength in relation to pubescent status and change. Several inferences or conclusions may be drawn from figure 11, which gives the increase in physical strength for one year with various categories of pubescent status and change. (1) The development of physical capacity is more than twice as rapid for a year in the P_{1-3} and

the P_{3-3} categories as for a similar period during pre-pubescence (P_{1-1}). (2) The change from pre-pubescence to puberty (P_{1-2}) is accompanied by what appears to be a smaller increase in strength than the increase in height and weight for the same period. See figures 3 and 4. (3) The most marked increase in physical capacity comes with the first year after the post-puberty stage has been reached. Since the most rapid growth in height and weight accompanies the shift from pubescence to post-pubescence, we conclude that the most rapid maturing of strength *follows rather*

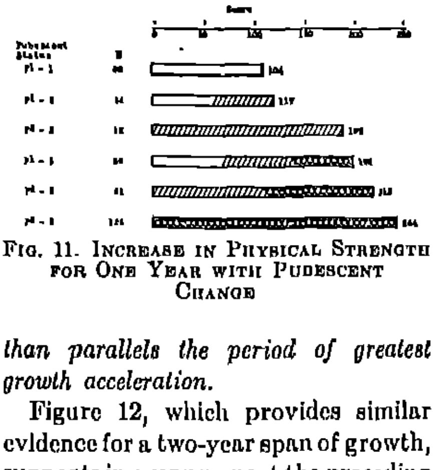


FIG. 11. INCREASE IN PHYSICAL STRENGTH FOR ONE YEAR WITH PUBESCENT CHANGE

than parallels the period of greatest growth acceleration.

Figure 12, which provides similar evidence for a two-year span of growth, supports in every respect the preceding conclusions. The fact that there is a greater increase in physical capacity for the P_{2-3} change than for two years at the post-pubescent level (P_{3-3}) is interpreted to mean that the second year of post-pubescence does not bring as conspicuous an increase in strength as does the first post-pubescent year. Other evidence showing a comparison of strength increase for the first and second years following post-puberty reveals this fact even more definitely.

In forming conclusions about physical strength and capacity of the adolescent from these facts a great deal depends upon the weight we give the tests employed as valid measures of strength. The combination of tests used appear to be adequate measures of the various elements involved in physical strength and capacity, including the factor of fatigue. We may state, therefore, with some degree of assurance, if not of decisiveness, that the physical strength of the boy who is passing through pubescence greatly exceeds that of the pre-pubescent both actually and in rate of increase. While it is not true that the adolescent

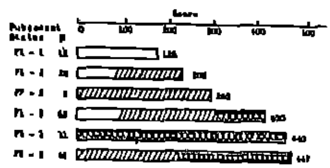


FIG. 12. INCREASE IN PHYSICAL STRENGTH FOR TWO YEARS WITH PUBESCENT CHANGE

boy is likely to be below par in strength in comparison with pre-pubescents of the same age, it is true that the sixteen-year-old post-pubescent, for example, may not possess the strength of the twenty-year-old of the same height and weight. In fact, the pubescent boy is likely to suffer in comparison with older persons of the same physical size. This statement is based on Roger's norms. This may partially explain the common impression that the rapidly growing boy does not have the strength and endurance commensurate with his size. He probably does not have the strength and endurance of adults of his own size. There is, evidently, throughout the

growth of the adolescent a lag in strength which is behind the potential strength of his physical frame.

PUBESCENCE AND MOTOR ABILITY

We turn now to the evidence bearing on the problem of what happens to the motor ability and coördination of the boy during the time of his pubescent development. A brief description of the tests used to measure motor ability will serve as background for interpreting the meaning of the results.

The tests employed were those developed and standardized by Brace (3). Twenty tests, chiefly of a stunt character, involving motor skill constituted the battery. The tests ranged in difficulty from such simple stunts as walking a few steps "toe to heel" on a straight line to extremely difficult feats of coördination and balance, such as jumping into the air, clapping the feet together twice, and landing with the feet apart. The coördinations called for by the tests were those considered basic in motor ability, and included a fair sampling of such elements as agility, balance, control, flexibility, and strength. That these tests measured something quite different from strength as measured by the Roger's test is apparent from the low intercorrelation of these two measures, which was .14.

Motor ability and age

It is immediately apparent from table 4 that motor ability as measured by the Brace Test does not increase with age during adolescence as swiftly as does physical capacity. The average score for the 12-year-old boy is 45, which means that he passed ten of the twenty tests. The average number of tests done successfully by the sixteen-year-old is thirteen, with an average score of 55. The increase in motor ability for the four years is 22 per cent, and in physical strength, 86 per cent. The correlation of age with motor ability (.16), when compared with the other physical measures, is further evidence that we are dealing with a type of abilities, or skills, that do not develop rapidly with chronological age during the adolescent years. Conceivably, this fact might be associated with the development of pubescence. The gain in motor ability with

TABLE 4

Motor ability scores of boys twelve to sixteen years of age

AGE					AVERAGE INCREASE PER YEAR	PER CENT INCREASE
12	13	14	15	16		
N						
90	152	176	99	26		
45.0	49.5	50.9	52.0	55.8	3.4	22

age is even less if there is any increase due to the "practice effect" which might be present in the second and third tests, each given at yearly intervals.

Motor ability and pubescent status. We approach, then, more specifically the problem of the effect of puberty, with its rapid physical development, upon motor coördination. Do the results of our study support the common notion that physical growth outruns neuro-muscular control, with awkwardness and clumsiness the almost inevitable results? We have treated our data bearing upon this

issue in four ways and shall review the results in the following order: (1) The motor ability scores of boys of the same age but of different pubescent status will be compared. (2) The growth scores in motor ability for one- and two-year periods for boys in each of the various categories of pubescent change will be presented. These data will indicate the pubescent stages in which the greatest and the least amounts of gain in motor coördination take place during one- and two-year

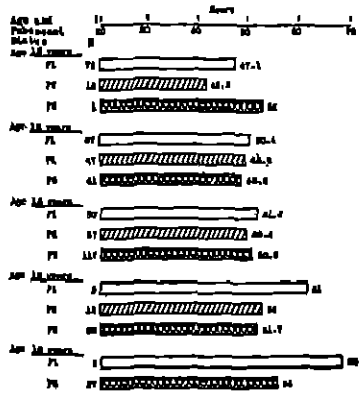


FIG. 13. COMPARISON OF MOTOR ABILITY SCORES OF PRE-PUBESCENT, PUBESCENT, AND POST-PUBESCENT BOYS AT VARIOUS CHRONOLOGICAL AGES

periods of growth. (3) We shall compare the *change* in motor ability scores *for one- and two-year periods* of boys who showed the *greatest increase in height and weight* with those who showed the least. (4) The correlations of motor ability with pubescence and other physical measures will be given.

Figure 13 presents graphically the mean scores of approximately 188 boys in the three annual tests of motor ability. We at once observe that the pubescent and post-pubescent boys have a lower score than the pre-pubescent boys at every age level. This excludes the one case of post-pubescence at 12 years of age. This difference is not large, except between the pubescent and pre-pubescent boy at twelve, but even the slight difference suggests the possibility of a general slowing up in the achievement of motor control with the arrival of puberty. An alternative to the interpretation of a general retardation of growth in motor ability with pubes-

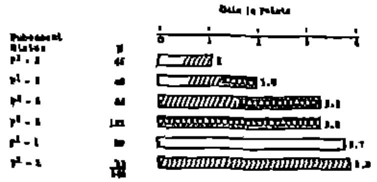


FIG. 14. INCREASE IN MOTOR ABILITY FOR 1 YEAR WITH PUBSCENT CHANGE

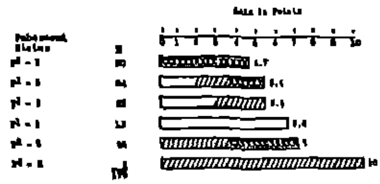


FIG. 15. INCREASE IN MOTOR ABILITY FOR 2 YEARS WITH PUBSCENT CHANGE

cence might be the possibility that there is a sufficient loss in the motor ability of enough boys to reduce the average for the total group. Further evidence in this report will bear upon these possibilities.

Change in motor ability with change in pubescent status. The mean growth in motor ability for one- and two-year periods for each of the 6 possible pubescent categories is given in figures 14 and 15. The interpretation of the results in the main is not difficult. (1) From figure 14 we would judge

that during the year in which the boy reaches puberty there is some increase in motor ability, as represented by the score "1," but it is only about one-third as much as for a year's growth either before or after puberty is reached. The question may arise here whether this difference is one of chance or of genuine importance. To answer this question the necessary statistical work was done in comparing the scores for the P_{1-2} group with those for the P_{1-1} group. The difference in means is only 2.6 times as great as the probable error of this difference, but even this ratio means that the probability is about 98 in 100 chances that the 2 groups are genuinely differentiated. The increase of 1.9 for the group who change from pre-pubescence to post-pubescence we interpret to mean that the development in motor capacity is slow around the pubescent stage, with a possibility of a faster development from pubescence to post-puberty. (2) The meaning of the findings for the two-year period as portrayed by figure 15 is not as clear. In general, the conclusions formulated from the data on one year's growth are reinforced. The two-year period during which the boy passes from pre-pubescence to puberty or to post-puberty is accompanied by the least improvement in motor coördination, with the exception of the two-year period on the post-pubescent (P_{3-3}) level. In the light of the increase of 3.2 for a single year after the post-pubescent stage has been reached, it is not easy to account for the increase of 4.7 for two years unless we assume that there is a substantial reduction in the rate of development in the second year of post-puberty.

We may assume from the foregoing facts that during the months around the time the boy reaches pubescence there is a slackening in the rate of increase of motor ability, but two facts should be clearly noted: (1) that *there is still improvement in motor ability, though it is less than before or after puberty;* (2) that *this is not the period, but precedes the period of the most rapid growth in height and weight.*

The findings shown in figure 14 do not indicate, however, whether the smaller gain in motor ability for the year in which puberty is reached represents an actual loss in motor ability coördination for some boys and a substantial gain for others or primarily a general reduction in the rate of gain for all. An analysis of the evidence on this problem not included in the report reveals the fact that the year during which pubescence is attained (P_{1-2}) about ten per cent fewer boys show any improvement than in the other stages of pubescent development.

Motor ability in relation to the amount of growth in height and weight. We shall now deal more directly with the question of the effect of rapid physical growth on motor coördination. The popular assumption has been that awkwardness in the adolescent boy is primarily the result of his rapid growth, that the more rapid the increase in height and weight the greater resultant clumsiness is likely to be. The large "overgrown" boy especially has been notoriously clumsy—in popular opinion. If this were true, we would expect the change from pubescence to post-pubescence to be paralleled by the least improvement, or greatest loss, in motor coördination, since that is when there is the greatest

acceleration in height and weight. This does not happen to be the case, however, in general at least, since the shift from pre-pubescence to puberty was seen to be the most crucial in its influence on motor ability.

As a more direct method of attack on this particular problem of the relation between rapidity of growth and motor coördination we studied the cases in the upper and lower quartiles of growth in height and weight and compared their change scores in motor ability. The results may be reviewed in table 5 and figure 16. The differences in the average change scores in motor ability for one year between the boys who showed the most and those who had the least growth in the same period is not significant. The boys who average a gain of 3.5 inches and the boys who average 18.8 pounds of growth in a year gain as much in motor ability, on the average, as do the boys who grow about an inch or gain five five pounds. Similarly, for the two-year period the boys who grow most rapidly in height and in weight, eight inches and forty pounds in some cases, improve as much in motor ability, on the average, as do the boys who grow but an inch or two in height and eight or ten pounds in weight. The increase in motor ability for the upper quartile group in height for 2 years, while not as great as for the lower quartile does not appear to be significantly different.

TABLE 5

Comparison of mean change scores in motor ability of cases in upper and lower quartiles of growth in height and weight for one and two years

	UPPER QUARTILE			LOWER QUARTILE		
	N	Mean growth	Motor ability growth	N	Mean growth	Motor ability growth
Height—1 year	85	3.5 in.	3.4	93	1.2 in.	2.0
Height—2 years	45	6.5 in.	4.0	49	2.7 in.	6.2
Weight—1 year	80	18.8 lbs.	2.5	80	4.3 lbs.	2.6
Weight—2 years	42	35 lbs.	5.9	44	10.3 lbs.	5.0

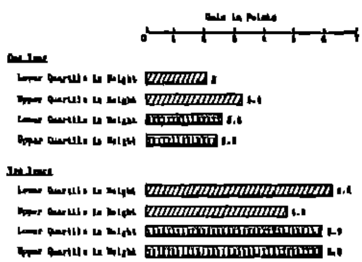


FIG. 16. COMPARISON OF MEAN CHANGE SCORES IN MOTOR ABILITY OF CASES IN UPPER AND LOWER QUARTILES OF GROWTH IN HEIGHT AND WEIGHT FOR ONE AND TWO YEARS

These findings seem to controvert rather convincingly the notion that marked physical growth is accompanied either inevitably or generally by disintegration of motor control. We present, however, the evidence shown in table 6 for a more detailed examination. These data are further supported by an analysis of other facts which indicate that as large a *per cent* of boys in the upper quartile of growth in height and in weight show a gain

in motor ability as in the lower quartile.

It may be, of course, that the Brace test of motor ability does not measure the kind of "awkwardness" which has been implied in the traditional concept. However, a standardized test, including twenty samples of performance which involved the elements of balance, agility, control, and other aspects of coördination, surely furnishes a more trustworthy guide than the impressions of uncontrolled observation.

TABLE 6

Distribution of change scores in motor ability of cases in upper and lower quartiles of growth in height and weight for one and two years

AMOUNT OF CHANGE IN MOTOR ABILITY SCORE	ONE YEAR				TWO YEARS			
	Growth in height		Growth in weight		Growth in height		Growth in weight	
	Upper quartile	Lower quartile	Upper quartile	Lower quartile	Upper quartile	Lower quartile	Upper quartile	Lower quartile
24– 29						1	1	1
18– 23	1	1	2	1		2		1
12– 17	11	11	9	12	10	8	10	8
6– 11	20	19	20	17	12	14	9	9
0– 5	31	33	32	35	14	18	14	22
−6– −1	14	21	15	16	6	4	6	1
−12– −7	6	4	7	3	3	2	2	2
−18– −13	2	4	4	5				
N..........	85	93	89	89	45	49	42	44

TABLE 7

Correlations of change scores in motor ability with change scores in other physical measures

MOTOR ABILITY WITH	ONE YEAR	TWO YEARS
Height..........................	.04	−.05
Weight..........................	−.01	−.08
Physical capacity..............	.08	−.01

Evidence from correlations

The final set of evidence bearing on the relation of pubescence and motor coördination comes from the correlation technique. In table 7 the correlation of change scores in motor ability with change measures in other physical factors may be reviewed. It will be observed that there is no significant association between the amount of change in motor ability and the amount of growth in height, weight, or physical capacity.

SUMMARY OF CONCLUSIONS

1. Physical strength, or capacity, as measured by the Roger's test, increases rapidly throughout the adolescent years, virtually doubling from age twelve to age sixteen.

2. The most rapid development of strength takes place during the year which follows the attainment of post-

pubescence. This suggests that the most rapid development in strength follows the period of most rapid growth in height and weight.

3. Motor ability, or coördination, as measured by the Brace test, increases throughout the adolescent years, but less rapidly in the period during which pubescence is reached (P_{1-2}) than during a similar period in the pre-pubescent status or following puberty.

4. The period of most rapid growth in height and weight is accompanied by substantial improvement in motor coördination.

5. The evidence yielded by an analysis of actual cases does not support the notion that where growth in height and weight is especially rapid loss of motor control, with subsequent awkwardness, is likely to take place.

We conclude, then, that awkwardness in adolescents is more likely to accompany the rather *sudden beginnings of growth* in the P_{1-2} period than the later and more rapid growth.

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The Influence of Verbal Directions on Behavior

MARGUERITE WILKER JOHNSON

THAT behavior and personality are modified by the speech of others and that special care should therefore be used in addressing verbal directions to children, has been recognized by many adults for centuries, largely on an intuitive basis. More recently their belief has been verified in part by experiments reported throughout the literature on the effect of verbal suggestion on both normal and abnormal subjects. But inconsistent variations in the advice now being given teachers concerning their own attitudes and conduct in relation to the children with whom they work indicate that conflictingly different interpretations are being made of both the intuitive belief which is stated in terms of principles and the experimental data which have reinforced some of the theory.

In either casual or directed observation of everyday practice, one encounters incidents like this one:

> "We shall now have our rest," said an adult to ten four-year-olds, "and we shall go on tiptoe for our rugs."
>
> Two of the ten children went on tiptoe and eight walked.

Such observation suggests a variety of questions for further study. Should nursery school teachers ask four-year-olds to tiptoe? At what age and under what conditions is there a dynamic relationship between directions to tiptoe and the learning to tiptoe? And what is the nature and history of such a relationship?

> Ten minutes later on the same day, the adult said, "Dick, you aren't having a very good rest today;" in a moment, "Bob, you lie down;" and still later, "Mary, stop wiggling."

No doubt all would agree that it is difficult to say, in the light of present-day knowledge, what effect such verbal influences are having on the behavior of children and on what basis of understanding, or lack of it, they are being used by adults.

In view of the fact that mere extent of vocabulary is one of the most reliable indexes of intelligence, as has been shown by Terman and others, a survey of one's verbal directions to others should yield considerable information as to his own intelligence, education, beliefs, and attitudes. Moreover, a systematic experimental survey of behavior in response to different verbal directions should yield additional information. It is even likely that some sort of an index to personality might emerge through experimental study of the words one speaks as directions and of the words one reacts to. This type of index, since language, spoken or reacted to, implies at least two people, would

undoubtedly yield some knowledge as to existing relationships between persons. More exact understanding, then, of the functions of different types of verbal expressions might serve both as a means for formulating helpful general principles concerning behavior and as a basis for devising further techniques for studying individual differences and personality.

With the expectation that verifiable evidence as to the relative effectiveness of different verbal suggestions used with children at all ages in various situations might answer some of the questions in child development and also indicate further profitable and systematic approaches to the study of child-adult relationships, the writer initiated a series of studies. Results have been obtained in 70 different experimental situations on the influence of verbal directions with children from three to seven years of age. A preliminary study and the general tendencies revealed in the first 6 situations of the larger study are reported in this paper. Lady O'Brien carried on the work of investigation under the direction of the writer.

A simple experiment was carried on in 1931 as an exploratory beginning in the attempt to find out how much difference would occur in a natural everyday type of situation in the behavior of 37 pairs of children when one child was given one type of verbal direction and his mate (in age, sex, and intelligence) was given a different type of verbal direction.

Seventy-four children ranging in age from two-and-a-half to seven-and-a-half years, enrolled in the University Elementary School at the University of Michigan, were invited by an experienced worker to go to a room, one at a time, to look at some new books. The room was furnished with a desk and chair for the worker, and a child's table and chair in one corner. Five new picture books were arranged in a pile on the floor, scattered in such a manner that the child in seating himself at his table would need to step over them. On entering the room with the child, the worker said to each member of the control group, "Someone left the books on the floor. You may look at them." To each mate in the experimental group, she said, "Someone left the books on the floor. Pick them up. You may look at them." The same attitude was assumed, as nearly as possible, with each child, and the words were spoken quietly. The worker took care not to express surprise or disapproval, but merely to state that someone had left the books on the floor. It is conceivable, of course, and highly probable that slight variations in expression occurred; but the work proceeded on the assumptions that complete control in the most precisely measured situations is as yet impossible, and that a systematic, though rough, study of phenomena so universal, constantly practised, and little understood as the influence of verbal direction might yield some true and pointed information about behavior.

Specifically, the questions in mind were, Will children aged two-and-a-half to seven-and-a-half years who are accustomed to finding books on tables or shelves, not on floors, and who receive daily training at home and school in placing books where they

belong, pick up the books without being told, "Pick them up"? Or, will they not feel free to do so or be interested in doing so, even though the books serve as an obstruction preventing easy accessibility to the chair? How much will the inclusion, for one group, of the words "Pick them up," and their omission for the other group affect the behavior of the children?

group. The age results in the experimental group with regard to placing the books on the table were: 13.5 per cent of the three-year-olds, 24.3 per cent of the four-year-olds, 24.3 per cent of the five-year-olds, and 27 per cent of the six-year-olds. The corresponding results for the control group were respectively 5.4 per cent, 0, 5.4 per cent and 8.4 per cent. The

TABLE 1

Relative effectiveness of two types of verbal directions in influencing children to pick up books from the floor

AGE IN YEARS	CHILDREN		PICKED UP BOOKS	
	Group	Number	Number	Per Cent
Three	Experimental	7	5	13.5
	Control	7	2	5.4
Four	Experimental	9	9	24.3
	Control	9	0	0
Five	Experimental	10	9	24.3
	Control	10	2	5.4
Six	Experimental	11	10	27.0
	Control	11	3	8.1
Total	Experimental	37	33	89.2
	Control	37	7	18.9
Difference in favor of experimental group			26	70.2
Probable error of the difference*				5.4
Difference divided by the probable error				13.0

* The formula $P.E._p = .0745 \sqrt{\frac{pq}{n}}$ was used in this study for the probable error of the proportion of successes.

All 74 children, the results indicate, spent some time looking at the books. In the experimental group 33, or 89.2 ± 3.4 per cent (Table 1) of the 37 children placed the books on the table. In the control group 7, or 18.9 ± 4.3 per cent, of the 37 children did so. The difference of 70.3 ± 5.4 per cent most significantly favors the directions given the children in the experimental

behavior of the children, then, at all ages was unquestionably influenced by the inclusion and omission of the words, "Pick them up." This preliminary study was followed by an investigation, extending over three years, of the behavior of the same children in different situations involving different types of verbal direction. A complete report of the entire investi-

gation to date on the relative effectiveness of different verbal directions with children, combined with a review of the experimental literature on the same subject, is being prepared for publication.

The procedures in the larger investigation were merely to ask the 38 children in the experimental group, one at a time, to perform simple tasks, to solve problems, and to inhibit certain tendencies by using one kind of verbal expression; and to ask their control mates to perform, in the same controlled situation, the same tasks, problems and inhibitions by using a different type of verbal expression. An attempt was made to place the child in attractive situations and ask him, with everyday kinds of requests to do simple things, interesting and natural to him. No attempt was made to use exact opposites in verbal directions since "opposites" are not known and may not even exist. The first 6 experimental situations are described in this report, with the materials and verbal directions that were used and the results that were obtained.

The 6 different situations or experiences occurred in the same order, one after the other, during one visit to a room that was set up in the same way for each child. The goals for the child, so far as the adult was concerned, were as follows:

1. To cut a circle from paper economically.
2. To refrain from opening a red box.
3. To persist in opening a Chinese puzzle box.
4. To dress a doll.
5. To untie a simple sailor's knot.
6. To complete a jigsaw puzzle promptly.

The children appeared to enjoy themselves and to take part willingly in all of the experiments. The immediate general goal for each child was to make a visit to a room to play games and the specific goals varied with the types of verbal directions given by the adult in the separate situations. Each situation was treated as here described, with only one request, which was made in the words reported. The children's visits to the room averaged about ten minutes. It seemed wise in this initial work to be governed by the natural course of events. Accordingly, the adult proceeded naturally with the child, without artificial time limits, guiding him unobtrusively from one experience to another.

RESULTS IN SIX EXPERIMENTAL SITUATIONS

1. *The Paper Circle*

A plain sheet of manilla paper 8½ x 11 inches in size, a pair of Bradley scissors, and a paper circle 3 inches in diameter were the only materials that lay on the child's table. On entering the room, the worker approached the table and said, as she held the paper circle before the child, "Cut a circle for yourself." Her subsequent directions were differentiated as follows:

E. To each child in the experimental group she said, "Cut it in the corner to save the paper."

C. To each child in the control group she said, "Don't waste the paper."

The criterion of success was to cut

the circle in any one quarter of the 8½ x 11 sheet of paper.

Results. The "Do" type of direction was very much more effective than the "Don't" type of direction in *this problem situation with children* learning to use paper economically. In the experimental group 26 of the 38 children, or 68.4 ± 5.09 per cent equalized somewhat, by the usual home and school training in the saving of paper. This finding appears to support the psychological admonition, "Tell children what to do instead of what not to do," and is also in agreement with a number of earlier results obtained in experimental situations with older children and adults.

TABLE 2

Relative influence of positive-encouraging (Experimental) and negative-discouraging (Control) verbal directions in six experiments with 38 children. The same 38 experimental children and 38 control mates were involved in each situation

SITUATION	PERFORMANCE	NUMBER OF CHILDREN SUCCEEDING		PER CENT OF ALL CHILDREN SUCCEEDING	DIFFERENCE IN FAVOR OF EXPERIMENTAL GROUP	D ÷ P.E.$_d$
1. Paper circle	Cut circle from one quadrant	Experimental	26	68.4 ±5.09	26.3 ±7.43	3.54
		Control	16	42.1 ±5.40		
2. Four boxes	Refrained from opening "red" box	Experimental	34	89.5 ±3.35	5.3 ±5.21	1.02
		Control	32	84.2 ±3.90		
3. Puzzle box	Persisted longer than mate in attempt to open box	Experimental	36	94.7 ±2.45	89.4 ±3.46	25.86
		Control	2	5.3 ±2.45		
4. Doll	Dressed doll entirely or in part	Experimental	36	94.7 ±2.45	60.5 ±5.74	10.56
		Control	13	34.2 ±5.19		
5. Sailor's knot	Untied sailor's knot	Experimental	35	92.1 ±2.95	42.1 ±6.22	6.77
		Control	19	50.0 ±5.47		
6. Picture puzzle	Completed puzzle sooner than mate	Experimental	23	60.5 ±5.35	21.1 ±7.55	2.79
		Control	15	39.4 ±5.34		

(Table 2), succeeded in cutting the paper circle from one of the four quadrants of the sheet of paper. In the control group 16, or 42.1 ± 5.40 per cent of the 38 children did so. The difference of 26.3 ± 7.43 per cent is significantly in favor of the experimental group. This difference would, no doubt, be still more striking if the children had not been previously

2. *The Four Boxes*

Four white pasteboard boxes, with covers, were placed on the table in front of the child. They were distinguished by colored paper circles on the covers, and contained the following materials:

1. Box with blue circle, a small toy auto.

2. Box with green circle, a wooden doll.

3. Box with yellow circle, a china doll.

4. Box with red circle, a pencil and some paper clips.

To each child the worker said, "There are toys in the boxes. You may look at them."

E. To the children in the experimental group she continued, "Leave the red box closed."

C. To the children in the control group she continued, "Don't open the red box."

The worker pointed to the red box as she spoke the words "red box."

Results. It appears that the "Do" type of direction tends also to be more effective than the "Don't" type in obtaining an inhibition in the behavior *of children. In the experimental* group 34 of the 38 children, or 89.5 ± 3.35 per cent (Table 2), refrained from opening the red box. In the control group 32, or 84.2 ± 3.99 per cent of the 38 children did so. The difference of 5.3 ± 5.21 per cent, while not statistically conclusive, is substantially in favor of the experimental group. Certain questions arise here which have already been the subject of experimental study, with inconclusive results in laboratory situations with older subjects. Does a "Don't" type of direction approach "positiveness" when prohibition is the goal? If so, by what process? If not, how may it be of assistance or hindrance with reference to or in connection with a positive "Do" type of verbal direction?

3. *The Puzzle Box*

An oblong Chinese puzzle box 1¼ x 4 x 0½ inches, permanently locked by a secret panel, was presented the child. To each child the worker said, "Open this box." When the child had persisted for 30 seconds by the stop watch, *further directions* were differentiated as follows:

E. To the children in the experimental group she said, "You can do it."

C. To the children in the control group she said, "Is it too hard for you?"

A record was made of the time the child persisted in his attempt to open the box. When he indicated with some note of finality, such as saying, "I can't do it," or "You do it," or by putting the box down or leaving it, the trial was considered ended.

Results. The findings are clearly in favor of encouraging rather than discouraging verbal expression. In the experimental group 36, or 94.7 ± 2.45 per cent (Table 2), of the 38 children persisted in their attempt to open a box longer than their mates in the control group. In the control group 2, or 5.3 ± 2.45 per cent, of the 38 children persisted longer than their mates *in the experimental group.* The difference of 89.4 ± 3.46 is overwhelmingly in favor of the experimental group. It should be said in passing, however, that discouragement as a mode of influence, cannot be summarily dismissed until the significance of 2 discouraged children's exceeding 2 encouraged children is understood. In general, encouragement as a device of

influence should be advocated, but in particular, discouragement should be investigated with reference to individual characteristics.

4. *The Doll*

An Effan Bee doll of medium size lay on the table with three articles of doll clothing, consisting of bloomers on a rubber band, an underslip, and a dress.

5. *The Sailor's Knot*

A short piece of clothesline rope about 3 feet long, in which there was tied a single sailor's knot, was handed to the child as the worker said, "Here is a rope."

E. To the children in the experimental group she said, "Untie this knot. Slip through here first," as she pointed to one end.

TABLE 3

The number of children succeeding at each age in response to positive-encouraging (Experimental) and to negative-discouraging (Control) verbal directions in six experimental situations

AGE IN YEARS	NUMBER CHILDREN IN EACH GROUP		NUMBER OF CHILDREN SUCCEEDING IN EACH SITUATION												TOTAL CHILDREN SUCCEEDING			
			Paper Circle		Four Boxes		Puzzle Box		Doll		Sailor's Knot		Puzzle Picture		Number		Per Cent	
	E*	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C
3	6	6	2	0	4	5	6	0	6	3	3	2	3	3	24	13	66.6	36.1
4	8	8	4	4	7	5	8	0	7	1	8	0	5	3	39	13	81.2	27.0
5	7	7	5	4	7	6	7	0	7	2	7	4	5	2	38	18	90.4	42.8
6	10	10	9	3	10	9	10	0	9	6	10	7	4	6	52	31	86.6	51.6
7	7	7	6	5	6	7	5	2	7	1	7	6	6	1	37	22	88.1	52.3
Total...	38	38	26	16	34	32	36	2	36	13	35	19	23	15	190	97	83.3	42.5

* E = Experimental, C = Control.

E. To the children in the experimental group the worker said, "It is time to dress the doll now."

C. To the children in the control group she said, "Do you want to dress the doll?"

Results. In the experimental group 36, or 94.8 ± 2.45 per cent (Table 2), of the 38 children dressed the doll, entirely or partially, when told to do so. In the control group 13, or 34.2 ±5.10 per cent, of the 38 children dressed the doll. The difference of 60.6 ± 5.74 per cent in favor of the experimental group may be considered statistically conclusive.

C. To the children in the control group she said, "Untie this knot."

Results. The more specific direction used with the children in the experimental group was significantly more advantageous to them in untying a sailor's knot than the direction given to the control group. In the experimental group 35, or 92.1 ± 2.95 per cent (Table 2), of the 38 children untied the knot. In the control group 19, or 50 ± 5.47 per cent, of the 38 children succeeded in untying the knot. The difference of 42.1 ± 6.77 per cent is very significantly in favor of the experimental group.

6. *The Picture Puzzle*

"Our time is up but here is a picture puzzle," said the worker to the child. A record was made of the time taken by the child to complete the puzzle. Four pieces for completion were used with the seven- and six-year-olds; 3 pieces for the five-year-olds and 2 pieces for the four- and three-year-olds.

TABLE 4

Relative influence for each sex of positive-encouraging (Experimental) and negative-discouraging (Control) verbal directions in six experiments. The same 21 boys and 17 girls in the experimental group and 21 boys and 17 girls in the control group were involved in each situation*

SITUATION	GROUP	NUMBER CHILDREN SUCCEEDING	PER CENT OF ALL CHILDREN SUCCEEDING	DIFFERENCE	D ÷ P.E.$_d$
1. Circle paper......	Experimental	Boys 14	66.7 ±6.93	3.9 ±10.10	0.38
		Girls 12	70.6 ±7.47		
	Control	Boys 7	33.3 ±6.93	19.6 ±10.71	1.83
		Girls 9	52.9 ±8.17		
2. Four boxes.......	Experimental	Boys 19	90.5 ±4.32	2.3 ± 6.81	0.34
		Girls 15	88.2 ±5.27		
	Control	Boys 18	85.7 ±5.13	3.3 ± 8.07	0.41
		Girls 14	82.4 ±6.23		
3. Puzzle box........	Experimental	Boys 20	95.2 ±3.15	1.0 ± 4.95	0.2
		Girls 16	94.2 ±3.82		
	Control	Boys 1	4.8 ±3.15	1.0 ± 4.95	0.2
		Girls 1	5.8 ±3.82		
4. Doll..............	Experimental	Boys 19	90.5 ±4.32	9.5 ± 4.32	2.2
		Girls 17	100.0 ±0		
	Control	Boys 2	90.5 ±4.32	25.8 ± 8.03	2.69
		Girls 11	64.7 ±7.82		
5. Sailor's knot......	Experimental	Boys 20	95.2 ±3.15	7.0 ± 6.14	1.14
		Girls 15	88.2 ±5.27		
	Control	Boys 9	42.8 ±7.30	16.0 ±10.67	1.47
		Girls 10	58.5 ±8.05		
6. Picture puzzle....	Experimental	Boys 16	76.2 ±6.27	35.0 ±10.20	3.4
		Girls 7	41.2 ±8.05		
	Control	Boys 5	23.8 ±6.27	35.0 ±10 20	3.4
		Girls 10	58.8 ±8.05		

E. To the children in the experimental group she continued, "You can do it promptly."

C. To the children in the control group she said, "Hurry up and do it. Hurry up."

Results. In this jigsaw puzzle task the advantage of a calm request informing the child of the need to work "promptly" is clear. In the experi-

mental group 23, or 60.5 ± 5.35 per cent (Table 2), of the 38 children completed the puzzle sooner than their control mates. In the control group 15, or 39.4 ± 5.34 per cent, of the "hurried" control children completed the task sooner than their mates. The difference of 21.1 ± 7.55 per cent in favor of the experimental group is practically conclusive.

An analysis of the results in the six different situations according to age and sex shows that the children in the experimental group were superior to their mates in the control group in doing as they were requested (Tables 3 and 4) for both boys and girls at all ages in all situations.

An analysis of the sex differences that occurred in three of the 12 different groups (Table 4) reveals the fact that boys in the control group failed to give the desired response in the *doll* situation (3) more often than girls in the same group when asked, "Do you want to dress the doll"? A few excerpts from the record of all spontaneous remarks made by the children in the various situations verbalizes some of the prejudices held by the boys against dolls.

M. T. "Well, I won't do it." "Yes, I guess I will." "Is this the way?" "I bet P. (a girl) knows how." "This is the first time I ever dressed a doll, and the last time, too." "I feel like a sissy." "I just don't like to dress dolls."

S. P. "Why, I don't play with dolls."

K. T. "That's a girl's job."

A sex difference seems to be indicated in the *picture puzzle* situation (6) where boys exceeded girls when directed, "You can do it promptly," and girls exceeded boys when told to "Hurry up." Considerable additional exploration of the effect of verbal directions involving time limits with young children is needed for clarification of the dynamic relationship that may exist.

A summary, then, of the more and the less effective verbal directions in this study can be listed as follows:

More Effective

1. "Cut it in the corner to save the paper."
2. "Leave the red box closed."
3. "You can do it."
4. "It is time to dress the doll now."
5. "Untie this knot. Slip through here first."
6. "You can do it promptly."

Less Effective

1. "Don't waste the paper."
2. "Don't open the red box."
3. "Is it too hard for you?"
4. "Do you want to dress the doll?"
5. "Untie this knot."
6. "Hurry up and do it. Hurry up."

In general, the greater number and per cent of successes achieved in each situation by the children in the experimental group, who were given the more positive, unhurried, specific and encouraging types of directions, as compared with the successes of the control children, who were given the more negative, general, hurried and discouraging verbal directions, indicates the superiority of the former over the latter types of directions. Some of these same situations have been repeated in subsequent experimental research, and additional results have also been obtained in similar, as well as in different situations in order that a study of individual differences and further interpretations might be based on more data.

Sex Differences in Skeletal Development

CHARLES D. FLORY[1]

EVERY one is aware of the many structural differences between the sexes. However, the extent to which boys and girls differ in their developmental rate needs further elaboration. Females are ahead of males in the speed with which they move toward physiological maturity, in the eruption of deciduous teeth, in the acquisition of locomotor ability, in the appearance of permanent teeth, in the onset of procreative ability, and in the completion of physical growth. Girls at any age and for any physical trait have attained a larger percentage of their maximum development than have boys of the same age. There is a growth potential related to sex which determines to some extent the rate at which growth and development take place.

It is the purpose of this paper to consider sex differences in the rate of skeletal growth and the degree of difference in skeletal development as revealed by roentgenograms of the hand. Some investigators apparently do not take into account the differential growth rate associated with sex, for they write as though differences in skeletal development were nonexistent or at least insignificant. Other authors have disregarded these differences except at the pre-adolescent period which has led to the postulation of significant pre-pubertal spurts in skeletal growth. Evidence will be presented in this study which seem to support Pryor's (6) contention that "The bones of the female ossify in advance of the male. This is measured at first by days, then months, then years." Pryor (7 and 8) has been accumulating facts during the past three decades which consistently indicate an increasing sex difference from birth to early adolescence.

The subjects.—Data for this investigation consist of more than 6,500 roentgenograms of the right hand of subjects from birth to maturity. One hundred newborn infants, 300 children from age one to four inclusive, 6,000 school children from the University of Chicago Laboratory Schools, and over 200 college students served as subjects in this investigation. These roentgenograms have been analyzed both by measurement and by inspectional techniques. The facts obtained will be presented to show the magnitude of sex differences in osseous processes from age to age.

Differences at birth.—Although the appearance and development of carpal bones are chiefly post-natal phenom-

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ena, children are occasionally born with one or more carpal centers. Adair and Scammon (1) show that ossification proceeds slightly faster in females in intrauterine life. Menees and Holly (5) found ossification among 4 per cent of the newborn males and among 12 per cent of the newborn females. Hess and Weinstock (4) found females ahead of males both among white and Negro children. The writer found ossification centers at birth in 2 per cent of the males' hands and in 8 per cent of females' hands. A typical hand at birth and the hand of a newborn girl which has two carpal centers are presented in figure 1. A consideration of sex difference on the basis of bone appearance alone shows that a given carpal center usually appears in the hands of girls before it does in the hands of boys, with an increase in the sex difference as the age of appearance increases. That is, the sex difference in the time of appearance of the capitatum is less than the difference in the average age for the appearance of the pisiforme. The radial epiphysis and the lunatum appear about six months earlier in girls' hands than in boys' hands, while the ulnar epiphysis appears one whole year earlier in the hands of girls. Pisiforme appearance suggests nearly two years of sex difference. These facts on the basis of bone appearance indicate an increasing sex difference in skeletal development at least until the beginning of adolescence.

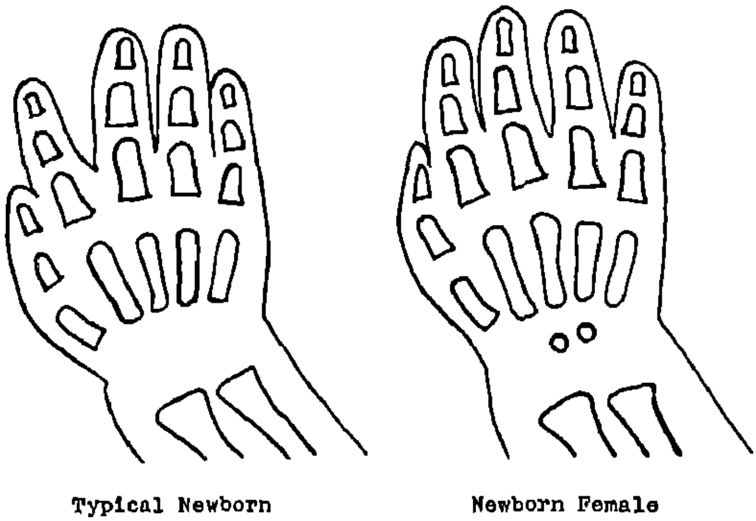

FIG. 1. OSSIFICATION IN A TYPICAL NEWBORN HAND AND IN THE HAND OF A NEWBORN FEMALE WITH TWO CARPAL CENTERS

Qualitative differences.—An evaluation of skeletal development on the basis of the quality of the ossification reveals significant sex differences. Figure 2 presents direct tracings from roentgenograms for a five-year-old girl and a six-year-old boy. These two

roentgenograms have been taken from a series of standards selected by the writer (2). They have been selected as typical of the development of each sex at the ages indicated. Inspection reveals that the five-year-old girl is fully as far along in her development as the six-year-old boy. It is significant indeed that there is a difference of one full year between the sexes in skeletal development at the average age for school entrance. By age twelve girls are as fully developed skeletally as fourteen-year-old boys. This two-year difference is maintained at ages *thirteen, fourteen, and fifteen.* Fifty per cent of the girls have reached skeletal maturity at age seventeen when epiphyseal closure in the hand is used as the criterion of skeletal maturity. Fifty per cent of the boys reach maturity, when judged by the same standard, at eighteen and a half, or one and a half years later than girls. Few studies dealing with sex differences in achievement or social adjust-

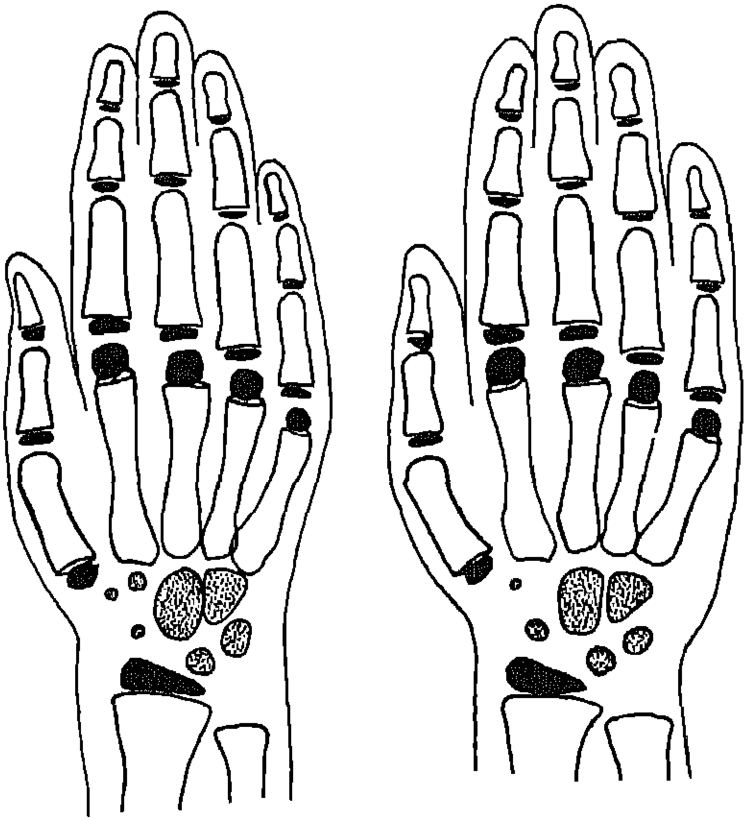

FIG. 2. OSSIFICATION IN TYPICAL HANDS FOR FIVE-YEAR-OLD GIRLS AND SIX-YEAR-OLD BOYS

ment have taken account of these physiological facts. The oversight has been in part due to the excessive emphasis on the differences between the sexes at adolescence with a neglect of the cumulating physiological superiority of females which has been in progress from conception.

at some point. Growth curves for these three bones for girls and boys respectively are presented in figures 3 and 4. Inspection of these curves shows at once that the crossing point is at eight and a half for girls and at ten for boys. This fact suggests approximately one and a half years of

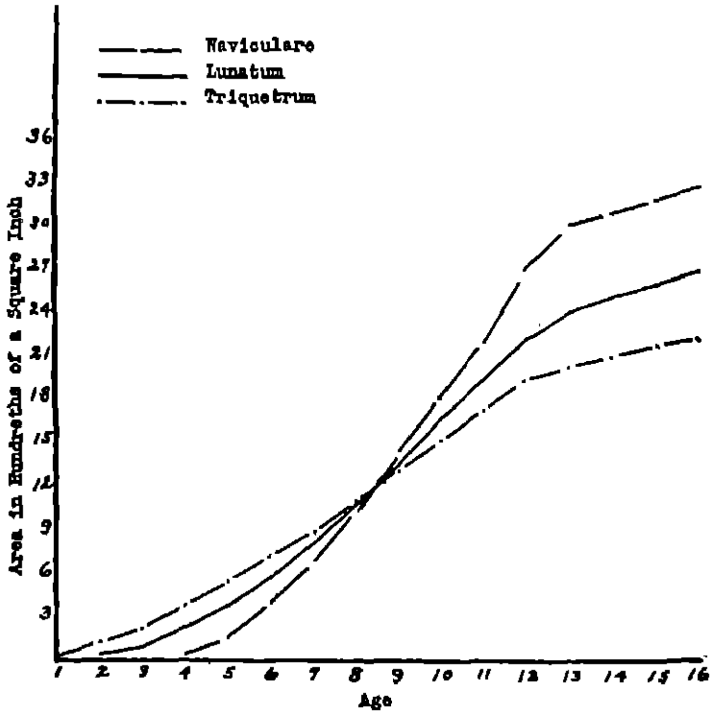

FIG. 3. GROWTH CURVES FOR THE NAVICULARE, LUNATUM, AND TRIQUETRUM FOR GIRLS

Differences in bone growth.—The size of the bone shadows in the roentgenograms of the hand have been determined from age to age by planimeter measurements. Inspection and measurement both show that the naviculare, lunatum, and triquetrum appear in the reverse order of their ultimate size. This fact means that growth curves for these three bones will cross

sex difference in skeletal development in the middle years of the elementary school or at about age nine.

Growth curves for the total area of all carpal bones suggest that girls are near their maximum at age fifteen while boys approach their maximum carpal development to about the same degree at age seventeen. Growth of bones in size indicates approximately

one and a half years of sex difference at age nine and two years difference at age sixteen. Girls are significantly ahead of boys in skeletal development when they enter the elementary school but they are still farther ahead when they enter high school, as long as chronological age is the major concept in school admissions and school progress.

Ossification ratios.—An evaluation of skeletal development by means of an ossification ratio (3) shows that there are significant sex differences. Growth curves for the total ossified area in the wrist and the area of the carpal quadrilateral are presented in figure 5. The ossification ratio equals one (1.00) at the point where these two curves cross. It can be seen from figure 5 that girls have an ossification ratio of 1.00 just prior to age 12 while boys have the same degree of development shortly before age 14. The ossification ratio therefore indicates two years of sex differences in skeletal development as children enter upon adolescence. Since the beginning of adolescence corresponds roughly with the age for high-school entrance, it appears that girls and boys differ approximately two years skeletally when they enter the secondary school due to differences in the rate of growth of the sexes.

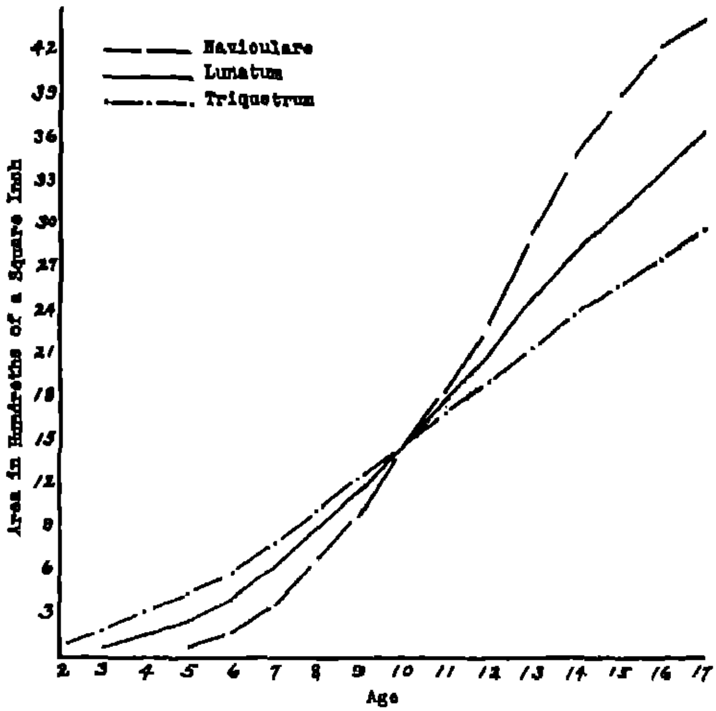

FIG. 4. GROWTH CURVES FOR THE NAVICULARE, LUNATUM, AND TRIQUETRUM FOR BOYS

Variability in skeletal development.—

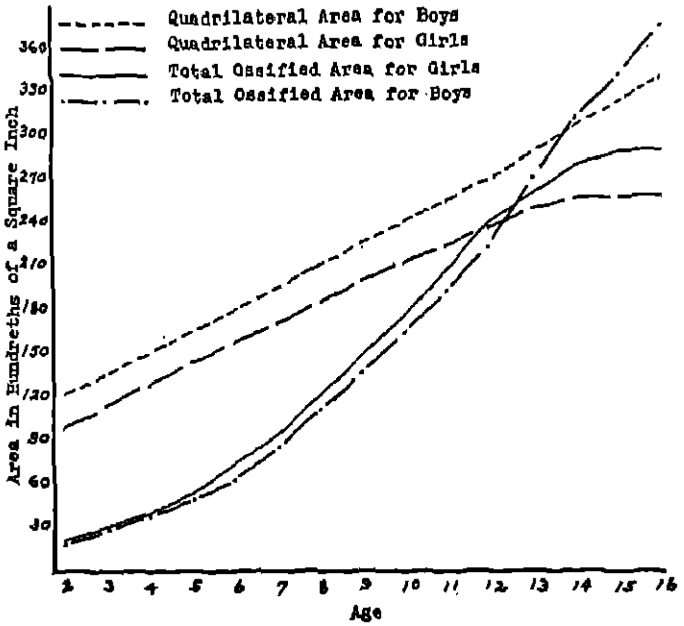

FIG. 5 GROWTH CURVES FOR THE TOTAL OSSIFIED AREA IN THE WRIST AND THE AREA OF THE CARPAL QUADRILATERAL FOR BOTH BOYS AND GIRLS

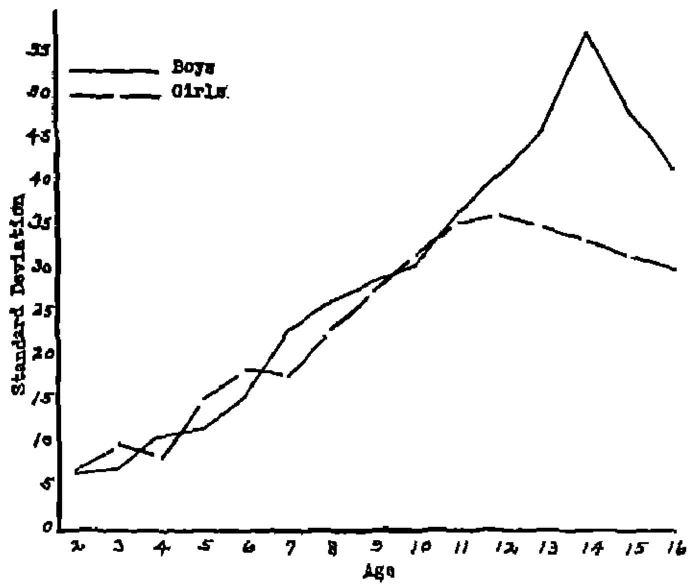

FIG. 6. THE VARIABILITY OF OSSIFICATION RATIOS FOR BOTH BOYS AND GIRLS

Evidence thus far presented seems sufficiently consistent to substantiate the contention that sex differences in osseous processes increase from year to year until the beginning of adolescence. Further evidence can be produced from an analysis of the variability in skeletal development. The variability from age to age for the ossification ratio is shown in figure 6. The ages at which these two curves for boys and girls reach their peak are significant. Girls are most variable in skeletal development, when evaluated by the ossification ratio, at age twelve. Boys are the most variable at age fourteen, two years later than girls. This point adds support to the contention that boys and girls entering high school differ about two years in skeletal development due to a more rapid physiological development among girls.

Standard deviations for skeletal months ratings, on a qualitative scale of development, show a similar degree of difference. Girls reach their peak in variability at age thirteen and boys at age fifteen. Here again a difference of two years is indicated. Another fact from qualitative ratings is quite significant. When ossification evaluations make use of epiphyseal closure as the final criterion of skeletal maturity, it is clear that zero or practically zero variability will be reached at maturity. University of Chicago Laboratory School girls reach zero variability on the qualitative scale at age nineteen. Boys do not reach zero variability until sometime beyond age twenty. Boys at age twenty have attained about the same stage of development as girls have reached at age eighteen. These facts indicate a two year sex difference through the secondary school and suggest that girls reach maturity about two years ahead of boys.

Conclusions.—The foregoing facts show to some extent the magnitude of sex differences in skeletal development from birth to maturity. Intrauterine growth rates are definitely related to sex. Girls are ahead of boys at birth; they are about one year ahead at school age; they are approximately one and a half years ahead at age nine; and about two years ahead of boys at the average age for the onset of puberty. Evidence has been presented which suggests that the differences in skeletal development due to sex are constantly increasing from birth to ages twelve or thirteen. Girls in high school are skeletally about two years ahead of boys. High-school administrators are dealing with a group of girls who are anatomically significantly more mature than boys. Girls reach skeletal maturity from a year and a half to two years earlier than boys. The increasing difference in skeletal development and the earlier maturation on the part of girls must be taken into consideration if a given school population is to be administered effectively and efficiently. Studies of sex differences in other aspects of development which disregard the maturity factor may have to be reinterpreted. It is true that some children have pre-adolescent spurts in growth but it seems to be of more importance to recognize fully the gradually increasing difference in osseous processes than to identify slight pre-pubertal accelerations in growth rates.

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Mental Deficiency in Relation to Inter-Marriage

Marian M. Rau

THE object of this study was to discover to what extent there was feeble mindedness among the children in the country schools of chosen districts of a county in Devon, England where there was reported to have been a great deal of inter-marriage due to isolation. The children were tested by Burt's Revision of Binet's Intelligence Tests and by a group of performance tests in order to have two tests of their intelligence. For a basis of comparison the children in an institution for the mentally defective were tested in the same manner. Their familiarity with the questions in the intelligence tests and training in certain types of performance were taken into consideration. The children in this institution were tested every year by the Stanford Revision of Binet, which is very similar to that of Burt's, and which gave them some advantage over the country children, none of whom had ever been tested before. Also these institution children have been receiving special training in drawing and handwork, and there is a possibility that this might raise their scores in the performance tests. After having considered the effect of these factors, the results were compared with those obtained from the country school in order to discover whether the country schools contained many children of the same low degree of intelligence that the government considered worthy of special institutional care under the Education Acts.

Burt's revision of Binet's tests follows the original closely as far as the material is concerned, the only difference being in the assortment and age assignments. This was necessary as the Binet-age Assignments which had been based on tests given to French children were not wholly applicable to English children. For instance, many older normal children in London, when given the tests appeared to be defective, and many defective younger children had higher results than they merited. The changes in the material itself in the tests are very slight, and when there was any modification, both forms are given and the cause for the change. Burt himself says that the alterations are only made in order to "carry out more completely the spirit of the original." He admits frankly that the version is not faultless, and that an entirely new series of scales must be constructed, but as this would demand a long time in research, he aims solely to give a version that adheres more closely to the original French authors than any other of the published forms.

Burt's tests were given in the man-

ner he suggests for the defective; that is, rather than starting at the tests appropriate for the child's actual age, as this would naturally mean working from the harder to the easier, the sequence was more or less governed by the following rules of Burt:

(1) The picture tests, coin tests, or name and age were given first in order to let the child get over his first feeling of nervousness.

(2) After this, when the child had become used to the examiner, the memory tests were given, then following up with the test requiring more effort, such as the oral problem tests. Care has to be taken of course that these tests are given when the child is at his highest point, pleased with having succeeded in the earlier tests, and yet not tired or bored.

The record of each child was kept separately, although the amount recorded was definitely limited by the fact that there was only one examiner, and, in order not to bore the child by long waits, only the necessary record was kept.

The performance tests were given in some cases as long as two weeks after the child had taken the Burt test, although in the smaller schools the interval averaged about two days. Certain tests for which scores for groups of children were available were chosen and combined into a performance test that seemed to include the necessary aspects of performance. Norms for these tests were obtained by averaging the scores made by children of normal intelligence in good country schools. The tests used were as follows: The Porteus Maze; The Knox Cubes; Manikin Test; Kohs Block Design test; Healy Puzzle; and Goodenough Drawing of a Man.

Scores of performance tests in schools used as normal schools

SCORE	NUMBER OF CHILDREN	APPROXIMATE C. A. OF CHILDREN
		years
10–14	5	5
15–19	12	6
20–24	15	7
25–29	23	8
30–34	17	9
35–39	21	10
40–44	13	11
45–49	3	12
50–54	6	13–14
55–59	7	15–16

Scores below 8 years not reliable.

These performance tests are important not only for judging the approximate mental age from the scores obtained, but to observe the methods of each child individually and to see why he failed or succeeded. Granting that the scores are in a manner a rather fair mark for if the method is good, the score is high, and vice-versa, but at the same time in certain individual cases success can be obtained by a poor method after a time. There is a rather good example of this with the manikin, where a child could obtain all four points, the complete score, even if he had made attempts to fit the arms in for the legs or any other more unintelligent response as long as he did not exceed the time limit. In generalizations for statistics of course all these methods cannot be considered, but if the child's case is to be studied individually, his manner of attack should be recorded for reference.

Village Number A, the first one visited, remains unique among the other villages in having by far the greatest number of inter-marriages among its inhabitants. As this is of greatest importance when the children's intelligence is being considered, in each case all the material that could be discovered was recorded. Considering the isolation of all the places that were visited, it is easily understood how a great deal of inter-marriage does take place, for there is no way for the inhabitants to mix with other people. For many years three or four large families have made up the sole population of the village. In quite a number of cases, when there have been highly intelligent individuals, they have not been satisfied with farm work, and have ventured out into a more populated district, leaving the duller ones behind to produce the next generation. In this specific case, the village was made up almost entirely of one very large family, which, according to legend, was started by a member of the Spanish Armada left stranded on the shores. The average Intelligence Quotient of the children of this family that were in the school was found to be 75. There was another large family, which, although not so large and old as the other, furnished quite a number of the small population. The average Intelligence Quotient of these children was about 90, only 2 being below the ninety mark, which shows that their mentality is definitely much higher than that of the first family mentioned. The weakness of this family lies mainly in their physical handicap. They are all undernourished and all except one have extremely bad eyesight. They are very small and thin, and appear to be susceptible to diseases that come into the school. In the first family 4 out of 5 of the children had parents that were first cousins, and the fifth had grandparents that were related, while in the second family 2 children out of 8 had parents that were first cousins, and no inter-marriage could be found among the other members. Of the rest of the children in the school, 3 of them were directly related to the first family, 2 of them had parents that were first cousins and 1 child had a mother in a home for mentally deficient patients. This last child was being watched carefully, and treated with rather extreme kindness, as she was definitely peculiar, and her relatives were afraid of her mental instability. All the children that have not come under one of the former classes came from scattered families about the village, and, although no definite inter-marriage was found, their parents were in most cases of the dull sort that one finds left in these isolated districts. Most of the children's fathers were farm laborers, receiving the set rate of 32/6d ($7.10) a week, although a few were mill workers, wood choppers and rabbit trappers. As the size of the families ran from four to ten, the struggle to get along was rather extreme in some cases. There were busses several times a day to the nearest town, and although the inhabitants would have to walk only a mile each way in order to catch a bus, the headmistress said that very few ever went, and those few went only to the cinema, and did not mix with the town people. While talking to a village

wood chopper, working on the squire's land, it was found that he had never left that part of the country because he was afraid of wild animals! This is just an example to show the extreme ignorance of these isolated people about the outside world. That man earnestly believed that there were wild animals in all other parts of the country that would hurt him. He willingly admitted that he could not "get on" here, as there were no opportunities, but he was afraid to leave.

The children in the schoo' had never seen a railway station un' they were taken by the present headmistress about two and a half years before. At present they very seldom went away, and some had never left the village. If they are taught anything about history or current events, all the subjects have to be in some way related to their present lives, or it makes no impression, for it is so very far removed. The whole atmosphere of the village was friendly, although a bit gossipy, and the people mixed among themselves quite well.

As far as the school was concerned, the work being done was rather doubtful, for, although the headmistress was very sincere in her attempts, and seemed to honestly believe that her methods were correct, anyone who has ever seen dull children taught in a special school would soon see that much was left undone. One could hardly blame this on the teacher, as she had received her training solely for normal children, and although she was very definitely interested in the children's mental state, she considered them hopeless. Her main complaint was of their very bad memories and lack of concentrating power. In the first place, she was not a woman of very steady nerves, and the situation had become rather acute by the time the visit was made. Her children were yelled at too much, and they were so continually being punished that it had ceased to mean anything to them. The school room was in a constant stir, both with the children talking and the teacher yelling at them, which is hardly an appropriate atmosphere for learning. As was said before, the blame cannot be placed upon the teacher, for unless she had been especially trained or adaptable to that sort of work, it can easily be seen that the situation was not an easy one. The fact that she had lost her husband a few months before and was only sleeping every other night when she took sleeping powders probably made a very great difference in her behavior, and it is hardly fair to judge her teaching from one visit.

Most of the children had to walk up a hill a mile long to come to school, and, as nearly all went home to lunch, they made the climb twice every day. This was rather hard on some of the very young children, though they did not seem to mind, even if they did get tired. The school hours were from 9.30 to 12.30; 1.45 to 4.30, with two short play periods There were two rooms, one for infants, and one for all the other standards together. For this reason there was a great amount of individual work done, as class work with so many different ages was impossible. The teacher stayed with the older children entirely, and the infants were taught by a supple-

mentary teacher, who was a distant member of the first family mentioned, although she seemed very capable and interested.

The results of the intelligence tests of the 32 children of this school may be seen from table 1. In this specific case, it can be seen from table 1 that 14 of the children had Intelligence Quotients below 90, 3 of whom are morons, 4 borderline cases, and 7 dull. This leaves 18 out of 32 that may be considered normal. In the performance tests, 30 per cent of the children were below their Mental Age, only 15 per per cent at, or below, their Mental Age, and 20 per cent above their Real Age. In comparison with the other villages this later score is not as bad as it might be, considering the state of their mentality.

Village B, the next one visited, had an entirely different character as far as both the school and the general atmosphere was concerned. The headmistress had only had the post for a few months, so she was not so very well acquainted with village people, but as far as it was possible to find out, there was no definite intermarriage among any of the children's parents. Nearly all of the families had been there for generations, so it is not hard to imagine that there must

TABLE 1

Frequency of intelligence quotients for Burt's revision of Binet-Simon test

INTELLIGENCE QUOTIENTS	SCHOOL							TOTAL COUNTRY SCHOOLS	INSTITUTION FOR FEEBLE-MINDED
	A	B	C	D	E	F	G		
20–24									2
25–29									0
30–34									5
35–39									7
40–44									8
45–49									8
50–54						1		1	12
55–59						0		0	10
60–64	1		1			0		2	9
65–69	2	1	0			1		4	5
70–74	2	0	1	1	4	3		11	1
75–79	2	2	3	5	7	3		22	2
80–84	4	1	6	3	2	5	1	22	2
85–89	3	3	7	0	4	4	0	30	1
90–94	4	1	7	4	3	5	3	27	
95–99	6	2	11	1	2	3	2	27	
100–104	4	1	2	3	0	2	2	14	
105–109	2	2	1	1	2	0	1	9	
110–114	1	1	0	0		0		2	
115–119	0		0	1		0		1	
120–124	1		1	1		0		3	
125–129			1			1		2	
Totals....	32	14	41	20	24	28	9	177	72

have been some inter-marriages. Also, the same thing has happened here as in Village A, for most inhabitants with initiative, had left for the towns. Inter-marriage was hinted at by some of the village people, but nothing definite could be found, with the exception of one family, all of whom were supposed to be too dull to get along, even with farm work. The isolation here was just about as complete as in Village A, for there was only one bus a week, and the people in this village used that, for they did not sell to a market. Nearly all the children get to the neighboring town, about ten miles away, once a year on the Sunday School picnic, but aside from that there was no way for them to get out and see other people. A few took the cattle into the fairs once a year, but this was only a few. The people were not very friendly among themselves, for, although there were no fights, everyone "minded his own business" and did not bother about his neighbor. There was very little gossip, as they seemed afraid to talk.

The children in the school were much more quiet than the children at Village A, and were under good control. Their secretiveness was marked, as with their parents. They looked as a whole fairly healthy, and there were only a very few undernourished. They of course were very poor, as in all these places, for the set wage for farm laborers is the same, 32/6d ($7.10). The present children have been neglected by a series of uncertificated teachers. None of them has stayed long enough to understand the work, and many have not been interested in their teaching. There is only one room and one teacher for 14 children of different ages, so some classes are always being neglected to a certain extent for the sake of others. The children of this school were tested in 1926 by a doctor and a large percentage were declared mentally deficient. The school has always been noted for its dull pupils. When the present headmistress arrived, the children were found to be very nervous and scared, but she reported that they were getting over this to some extent, though some still cried very easily. Many of the boys had to help on their father's farms before they came to school and after they went home, and although this work appeared not so hard as to hurt them physically, it did take some of their strength away from their school work. Table 1 shows the record of the Intelligence Quotients of all the 14 children tested, but as in the first case, the average cannot be taken as wholly representative, due to the few numbers. In this case, of the 14 children tested, 7 were below normal, 1 of whom was a moron, 2 borderline cases, and 4 dull. This meant that half of the children in the school were mentally defective to some extent. In regard to their performance scores, 35 per cent were at or above their Mental Age; 28 per cent were below their Mental Age. Only 1 child was above his Real Age in performance.

The next village visited, C, had an entirely different atmosphere from the other two visited, although it was similar in so much as it was also a farming village and very isolated. The inhabitants seemed to have much more of a mean spirit and bad feeling toward one another than in either of

the other places. It was said later that perhaps this was due to the fact that years ago a great many Irish people had settled there, and as they were naturally fighting people, perhaps it had been handed down to this generation. This is merely a supposition, of course. Among the villagers there were very often stories of fights among the men, and sometimes among the women. Also there were very often family feuds, which generally contributed a few first squabbles every year. These people seemed to be of a wilder type than was found in the other districts. The isolation was just as complete, for there was only one bus a week, and the people could not afford to take that, so they remained in the village. The people were all fairly religious in so much as they all belonged to the church or chapel, although they did not attend frequently. Their poverty was as extreme in this case as in the others, for the wages were the same, and although a few had small holdings of their own, they barely managed to live off of them. In a few cases the children were undernourished for most of the milk and food had to be sold in order to obtain money for their clothes and other expenses, or was saved in the bank. There was an institute in a village a mile away where the men went for games at certain times. There was also an institute at the same place for women once a month for lectures, handicrafts, etc. The headmistress said that this had made quite a difference among the people. There was still a strong belief in witchcraft among the parents of the children, and on one case a woman threatened another woman and blamed her for "overlooking" her child and causing her to have scarlet fever. There was also a case in the village of a girl very earnestly believing that she had been cured by a witch doctor in the nearest city. Although the children themselves had not as yet shown signs of beliefs such as these, having it so firmly planted in their environment these beliefs probably influenced their responses.

The school itself is comprised of 47 children, two school rooms with one headmistress and one assistant, the latter not being very well trained. The headmistress was exceptionally good, and realized what she faced in trying to teach most of her pupils. If the children do work for scholarships and receive them, their parents will not let them go, for they do not like for them to leave home. None of the children had seen the sea until they were taken by the headmistress when she first came. A trip has been made every year since. Some of the children were so very shy that they often did not even speak or answer the headmistress after being in school as long as three months. There were three of this type present when the tests were given, and it was impossible to find any way to make them answer. They were so dreadfully frightened of a stranger that all they would do was to cry. Many of the children had to walk as far as two and a half miles to school, all of it hilly. The headmistress tried to get the committee to bring the little ones to school every morning, that way eliminating their climb up the hill, but they would not do it. Many of the older boys helped

with the farms before and after school, and in hay-making time they often worked until eleven or eleven-thirty at night. The school hours were from 9.30 to 12.30; 1.30 to 4.00. This early closing was made so that many of them could get home in the winter before dark.

The children under the headmistress were taught exceptionally well as she had been a trained teacher with experience before she took this post. She had nearly all individual work because of the differences in the ages, and the children that definitely could not learn, she allowed to concentrate on more manual tasks. The average Intelligence Quotient of the school was not very low, as can be seen from table 1, for there were a few fairly bright children, but there were also quite a few even below the dull mark which were a problem both for the village and school. In this case there were 18 out of 41 children who were defective, 1 of whom was a moron, 4 borderline cases, and 13 dull. In this school also, almost half of the children were definitely below normal in intelligence. In their performance tests, 48 per cent were below their Mental Age, 12 per cent at or above it, and 10 per cent about their Chronological Age. This school was lower in its performance scores than any of the previous ones.

The case was very nearly the same in Village D, for they were only 1 mile apart, and the character of the villagers were somewhat alike. There were 30 children on the roll when the tests were made. There used to be many more, but the village had gone down a great deal. There was a village hall where the institute holds its meetings, and also a Public House. The children went to a neighboring town once or twice during their vacations, and also, they had one or two outings a year when they get away from the village. Although this village is only one mile away from the other, the people were of a different nature in so much as they were friendly. There is none of the fighting or feudal feeling that there was in the other place. The mothers seldom come to the school, so the headmistress really knew very little about the village life. Most of the fathers were farmers or farm laborers as in the case of the other villages, but there was more central feeling as the village was larger and they live nearer to one another.

As for the school, there were 2 rooms, with 1 teacher and 1 helper for the infants, the latter being only a young country girl with elementary education. The headmistress tried to bring the children out of the infants' room as soon as possible so as to be able to teach them herself. The children were quiet and easy to control and seemed quite interested in their work, this being mainly due to the teacher's good methods. Many of the boys have to work on the farm before they come to school, but none of them does so much work that they have to get up before seven. There has been no direct inter-marriage of cousins among the children's parents, which was the same case as the former nearby village tested, but in both cases there had been a great deal of this in former times. Most of the children had to walk from one to two and a half miles to school, but quite a number of them stayed for

lunch, so the distance they walked was not so very great. Although the mean Intelligence Quotient was a point lower in this case than in the neighbouring village, the extremes did not seem to be as great, although the headmistress seemed to consider some of the lowest impossible to teach. In this case, 18 out of 29 children were mentally deficient, which is a very great percentage. Of these, 6 were borderline cases, and 12 were found to be dull. In their performance tests the percentage below and above the normal mental age was 24 per cent in each case. There were 20 per cent with mental ages above the normal and this is the highest score received by any of the schools.

The next village, D, was about the most depressing and hopeless of them all. Not only were the children duller, but their poverty seemed to be more extreme. Many of them were in rags, and although only 2 of the 26 tested were reported as undernourished, they all looked rather poorly fed. The schoolmistress was a village girl that had received her certificate while teaching in another country school, and had come here as headmistress to be able to live at home. As she was a native of the village the material that could be obtained about the inhabitants was so definitely biased that it was of no use, so a visit was made to the vicar who was very considerate and helpful. Although he knew of no marriage of first cousins in this district for years, he said that there had been a great deal of inter-marriage due to the fact that no new people had come in to live, and that the opportunity for marriages was very limited. This village was written about in one of Blackmore's novels, and at that time was very wild, so a great improvement had taken place, although much more was needed even at present. The vicar's main complaint was that the village people did not have enough connection with the outside world. Although there were two busses a week to the nearby town and one once a month to the nearest city, very few of them ever left their own homes. He had worked for a telephone for the post office for years, and had finally succeeded a few months before to get one installed. It had helped quite a good deal as far as obtaining a doctor was concerned, but of course it had had no beneficial effect upon getting the people out of their narrow lives. Among the older people there was still a great belief in the witch doctor, *"overlooking,"* the evil eye, etc. The vicar knew a man who died two years before because he was positive he had been "overlooked" and no one could convince him otherwise. He had believed that a man in the village had power to cure him although he was not a regular witch doctor.

The school consisted of about 29 children generally, with two rooms, one teacher and a helper for the infants' department. The headmistress appeared to be a fairly capable teacher, only she did not realize the low intelligence of her pupils. There were quite a number of her relatives in the class who were just as dull as the rest. She was willing to admit that none of them was brilliant, but she really believed that they were of good average intelligence. The school

hours were 9.15 to 12.15; 1.30 to 4.00. Most of the children had to walk from one to two miles from home to school, but they stayed at the school for lunch. The average child gets into the small neighbouring town only about once a year, if that frequently. The results of the tests were rather drastic, for only one child out of the 26 had an Intelligence Quotient of 100 or above, the lowest starting at 70. When one considers that these children have no hope of ever getting away from their present environment, and that they will probably marry each other, the situation becomes more acute. The school was not a great help, as their teacher was of the same sort, although of course not low mentally, but as far as finding any connection with the outside world through their school, the children are absolutely helpless.

In this school, 17 out of 24 were mentally defective, and only one child had an Intelligence Quotient of 100 or above. Of the defective ones, 11 were borderline cases, and 6 were dull. In performance, the scores were correspondingly low, as 50 per cent were below their mental age and only 16 per cent at or above it, and 2 children above their real age.

The next two villages visited, E and F, can best be described together, for they were similar as far as the type of children attending the schools was concerned. Although both of these villages were populated by farms, as in the other cases, there was an entirely different type of person there. They were both situated in the hills, about a mile up from the better farming land, so the people there were very generally poor farmers and could not hold on to their good land, or they had been people who could not get along with the others, and had had to move away. They were very quarrelsome and bothered the school work a great deal, particularly in school E. In this case, the present headmistress was the only one that the school had ever had who had got along well with the people. She managed by always laughing when they came to her with complaints. The people themselves did not get along together at all well, for the villages were full of petty jealousies. They would not even attend Jumble Sales at the schools, for one woman would not come if another brought anything. There were no busses to the neighboring towns or cities and many of the families never left the villages, quite a number of whom had children in the schools. There was no social life at all, for, although many of them were related, they did not like one another. There was a Public House in Village E, but there was not much drinking for there was no money. All the families had inter-married a great deal, and although none of the children had parents who were first cousins, the stock had been weakened a great deal, both by the general inter-marriage and by the best children leaving for the town when they grew up. In a talk with the vicar, who had resided there for thirty years, it was found that he had a very strong dislike of institutions, and boasted that since he had been there he had kept as many as 20 children from being sent to a nearby institution which happened to be the institution in which tests were given. He believed that they were better off with

their parents! He also showed his extreme narrow mindedness by not believing in higher education for girls, but this did not affect his parishioners to a great extent as none of them was capable of getting very far in education.

The two schools were not as much alike as the villages, so they will be dealt with separately. School E had about twenty-nine children ordinarily, but at the time of the testing several were away helping their fathers with the hay-making. The headmistress complained a great deal about the amount of work her pupils had to do at home, for she thought it was too hard for them, and that it took too much strength from their class work. The farms were too poor to afford any paid help, so the oldest boys generally had to do all the work that their fathers could not manage to get done. Many times they had to stay away from school for this. The school hours were from 9 to 12; 1 to 3.30 and many of the children had to walk as far as two and a half miles to come in the morning, after working hard on the farm. The children looked fairly healthy, but the headmistress believed that quite a number of them did not get enough of the right sort of food. Her main trouble with them was to get them to concentrate, for she said that unless she kept them at attention all of the time, their minds wandered dreadfully. She had taught two years in an open air special school, so she was particularly well trained for this position. She realized what she faced in the way of mentality, and did the most she could do. There were two rooms, and she had a fairly capable teacher for the infants. The school seemed to be very well run, and although the children were talkative, they were kept in good order. In the school 18 out of 28 were defective, 2 of whom were morons, 6 were borderline cases, and 10 were dull. In this case again over half of the school was below normal in its intelligence. The performance scores show that none of the children are at or above the average or normal score and 50 per cent are below.

School F was very much smaller, only 9 children, 2 of whom were children of the headmistress. The school had been much larger, but due to a fight over the church's grazing ground, one of the largest families declared that the vicar had an "evil eye," and that they would not have their children in a cursed school, so they removed them to School E. The firm belief in witching was found in both of these villages more than in the better farming districts. Needless to say there was only one school room for all the children, and one teacher. She had taught in city schools, and seemed a capable teacher. Although the tests showed that there was only one child below 90, who could really be called dull, she despaired of their intelligence, and thought they were extremely hard to teach. Although her class was small, she worked hard and was conscientious about all their subjects. The children all looked healthy, and in general, seemed to be a better class of children than in School E. The headmistress seemed to think that she had got rid of her worst ones when the family had the fight with the vicar. The school hours were the same as for

School D, and the distances approximately as far. The children were under good control, and appeared to be interested in their work. As there were *only 9 children attending this* school it is not a very convincing example, for the 9 attending are of fairly high intelligence in comparison with the others. Only one child could really be called dull, but also, only 2 children reached the Intelligence Quotient of 100, and one of these was the child of the headmistress.

of the same in the country schools combined. This perhaps might be due to the training at the institution, which necessarily includes more activ*ity similar to the performance tests,* as they are catering to a whole group of mentally deficient, and do not have to include all the other subjects that must be taught in regular elementary schools.

In the Goodenough "drawing-a-man" test the percentage of children at or above the norm in the institution

TABLE 2

Frequency of mental ages for performance tests

PERFORMANCE MENTAL AGE	SCHOOL							TOTAL COUNTRY SCHOOLS	INSTITUTION FOR FEEBLE-MINDED
	A	B	C	D	E	F	G		
years									
Below 8	14	6	14	12	9	22	4	81	43
8	5	2	7	3	7	2	1	27	7
9	4	5	11	5	3	1	3	32	10
10	3	1	5	5	5	3	1	23	8
11	1	0	1	2	0	0	0	4	2
12	4	0	0	0	0	0	0	4	1
13	0	0	0	1	0	0	0	1	0
14	1	0	1	0	0	0	0	2	1
15	0	0	0	1	0	0	0	1	0
Totals....	32	14	30	20	24	28	9	175	72

From table 2, the results of the performance tests of both the institution and the school can be seen and compared. There seems to be no reason why the percentage of children above their real age in performance should be better in one school than another. Taking all the country schools together, the largest percentage seem to be below normal mental age in performance tests. The percentage of institution children at or above the normal mental age was noticeably higher than the percentage

is very much higher than the same in the country schools. As the test is not supposed to depend on training, this can hardly be explained in the same manner as with the performance scores. The children obviously forget all they have learned about drawing when they are asked to draw a man from memory. Anyway, there is adequate attention given to drawing in the regular schools. The number of children among the normal schools who are below their mental age in this drawing test is even more alarming

when you consider how low some of the mental ages are below their real ages. Being able to draw a man is one test of intelligence, and so this shows just how backward these children are as a whole.

The institution tested was a fairly large one, devoting a great deal of time to the training and keeping of certified mentally defectives. The 72 cases that were tested in this research were education cases, *i.e.*, those sent there by organizations and schools for special training until they were 16. Most of the class work was carried on by trained nurse-teachers, and supervised by a very well trained headmistress and headmaster. Some domestic training for the girls was emphasized, and some of the boys learned trades, though in general, for these cases, most of the work was scholastic as far as possible. The children seemed very happy, although an institutional air prevaded, as it always does, no matter how much attempt is made to keep from it. The place was very friendly to research workers, and was extremely interested in any new material that might help them in their work. It seems to be a well managed place and

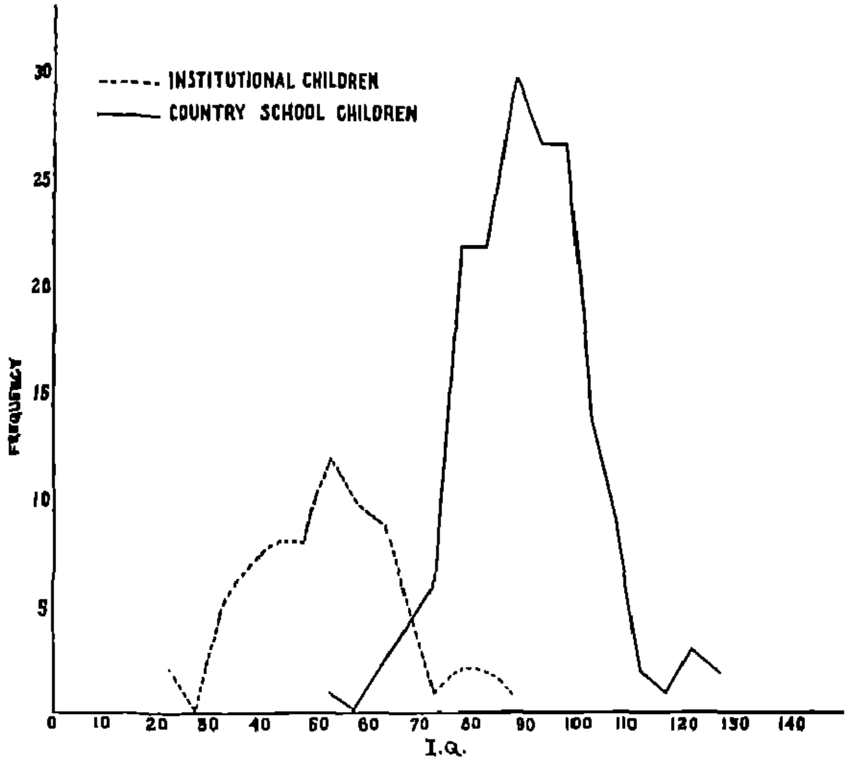

FIG. I. FREQUENCY OF INTELLIGENCE QUOTIENTS FOR BURT'S REVISION OF BINET-SIMON TEST, COMPARING INSTITUTIONAL AND COUNTRY CHILDREN

deserves credit for a great deal of hard work. If quite a number of the dullest cases in each village school tested would be allowed to be sent here, there would probably be a great improvement in their attainments, for a place well equipped for special children would seem to give them better training than a headmistress that has not the time or training. Of all the children tested here, one was an idiot, 29 imbeciles, 36 morons, 3 borderline cases, and 3 were found dull.

Intelligence Quotients of the combined village schools illustrated in figure 1 shows that 92 of the 169 rural children that were tested were mentally deficient, the mean Intelligence Quotient being about 89. The correlation between the Intelligence Quotients and the performance scores is .618 which shows a tendency toward a similar group ranking for both forms of tests.

The results show the condition both of the villages and schools in isolated pockets of the county and the effect upon the mental development of the children. The influence of inbreeding also appears to be a highly contributing factor in mental deficiency and in emotional instability.

An Analysis of the Literature Dealing With Nursery Education

Dorothy E. Bradbury and Esther Leech Skeels

One of the values of bibliographical research is that it may indicate certain trends within a field. With this in mind an analysis was made of a bibliography of nursery school education published by the National Association for Nursery Education covering material appearing up to December 1934 (2). Eight hundred forty references comprise the bibliography.

It includes publications dealing specifically with nursery school education and published in the United States, with as many from English as could be identified. No attempt was made to include references written in languages other than English. The distribution according to publication dates is as follows:

Year	*Publications issued*
1919	2
1920	3
1921	1
1922	9
1923	10
1924	15
1925	40
1926	51
1927	62
1928	104(92)
1929	88
1930	93
1931	102
1932	90
1933	95
1934	60*
Total	840

* Eleven months.

The total of 104 in 1928 is somewhat misleading in that it is largely due to the fact that the individual chapters of the Twenty-Eighth Yearbook of the National Society for the Study of Education on *Preschool and Parental Education* (3) were listed separately. Twelve of the references issued in 1928 can be accounted for in this way. Only eleven months of 1934 are included. The low level of this year can be partially explained by the fact that some of the magazines containing the most references on nursery education are quarterlies which normally appear in December, namely Child Development, Progressive Education, Pedagogical Seminary and Journal of Genetic Psychology, and Journal of Experimental Education.

Only six publications were issued prior to 1922; whereas 50 per cent of the material has been published since 1929. This fact indicates the momentum with which the field of nursery education has developed.

The following individuals are each credited with five or more publications in the field.

Individual	*Publication*
Davis, Mary Dabney	18
Gesell, Arnold L.	16
Stoddard, George D.	15
Woolley, Helen T.	15
Goodenough, Florence L.	12
Johnson, Harriet M.	10
McMillan, Margaret	10

Individual	*Publication*
Langdon, Grace	10
Alschuler, Rose H.	9
Meek, Lois Hayden	9
Earle, Rebecca K.	8
Hill, Patty Smith	8
Foster, Josephine C.	7
Eliot, Abigail A.	6
Harley, C. Winifred	6
Kawin, Ethel	6
Updegraff, Ruth	6
White, Edna N.	6
Anderson, Harold H.	5
Anderson, John E.	5
Baruch, Dorothy W.	5
Christianson, Helen M.	5
Conrad, H. S.	5
Hulson, Eva L.	5
Jersild, Arthur T.	5
Koch, Helen Lois	5
Manwell, Elizabeth Moore	5
Vance, Thomas F.	5
Wellman, Beth L.	5

The classification used in the bibliography together with the number of references in each category is listed:

Classification	*References listed*
Viewpoints and Philosophy	56
Survey	393
Historical Development	29
Present Status	60
Conference Reports	32
Comparison of Nursery Schools With Other School Levels and Institutions	14
Description of Nursery Schools	196
In America	160
In Colleges, Universities, and Training Schools	70
In Independent Research Centers	18
In Public Schools	19
In Private Schools	6
In Coöperative Nursery Schools	21
In Independent Private Nursery Schools	8
In Social Welfare Agencies	15
For Handicapped and Sick Children	3
In Foreign Countries	36
Contribution of Nursery Schools	55
Biography of Leaders	4
Bibliography	3
Nursery School Organization and Administration	11
Housing	4
Budgets	1
Schedules	2
Records	4
Nursery School Procedures	126
Underlying Principles	20
Health	10
Nutrition	5
Clothing	5
Teaching Techniques	4
Habit Formation	6
Mental Hygiene	4
Personality Problems	10
Play and Play Equipment	23
Science Experiences	4
Children's Literature	8
Music	5
Art	3
Parent Education	19
The Nursery School as a Training Center	21
Preparental Education	6
Preparation of Teachers	13
Preparation of Nurses	2
Research in Nursery School Education	233
Research Techniques	22
Attendance	5
Measurements	31
Intelligence	10
Personality	21
Physical Development	6
Health and Nutrition	6

Classification	*References listed*
Motor Development	4
Mental Development	52
Sensory	5
Imagination	1
Learning and Problem Solving	20
Comprehension	2
Language	18
Habit Formation	27
Emotional Development	10
Social Development	20

Play	12
Art, Rhythm, and Music	18
Social Background	3
Comparison With Non-Nursery School Children	2
Teaching	3
Possibilities for Research	9
Grand Total	840

In analyzing the component parts of the outline used in the bibliography some interesting information was obtained. Under the category *Description of Nursery Schools,* the following distribution according to years resulted.

Year	*Publications issued*	*Per cent of total issued during year*
1922	2	22
1923	10	62
1924	3	20
1925	21	43
1926	12	24
1927	20	32
1928	23	22
1929	24	27
1930	18	19
1931	19	18
1932	17	19
1933	17	18
1934	9*	15*

* Eleven months.

From the above tabulation it is apparent that the proportion of descriptions of nursery schools in relation to the total number of publications dealing with nursery education issued during a given year has tended to decline since 1923, although the proportion has fluctuated from time to time. The first article classified purely as a description of a nursery school was issued in 1922; this reference is antedated by the book edited by Grace Owen *Nursery School Education* (4) which, although primarily concerned with the philosophy of nursery education, does include descriptions of specific nursery schools.

In sharp contrast with the above distribution of publications, is the distribution of research[1] references given below.

Year	*Publications issued*	*Per cent of total issued during year*
1924	1	6
1925	3	6
1926	4	8
1927	6	9
1928	28	26
1929	14	15
1930	20	31
1931	35	34
1932	46	50
1933	50	52
1934	17*	28*

* Eleven months.

If the incomplete returns for 1934 are discounted, there is a steady increase in the proportion of research articles as compared to the total number published. The first article that can be classified as a research in nursery education appeared in 1924 and was issued by Andrus (1). The number of references falling under the category of research indicates how the activities of the nursery school program are being analyzed and evaluated.

The following tabulation shows the magazines containing the greatest number of articles. No magazine is listed that did not contain five or more articles.

[1] In this classification a research was considered one in nursery school education if it dealt with or had a definite bearing on nursery school procedures or the effect of nursery school practice upon the child. No attempt was made to include all the researches in the field of child development in which nursery school children were used as subjects

Magazine	Articles
Childhood Education	123
Child Development	60
American Childhood*	41
Pedagogical Seminary and Journal of Genetic Psychology	31
School and Society	21
New Era	20
Progressive Education	20
Journal of Home Economics	18
School Life	10
Genetic Psychology Monographs	10
Journal of Experimental Education	10
Survey	9
School and Home	9
Child Health Bulletin	9
Addresses and Proceedings of the National Education Association	7
Scottish Educational Journal	7
Public Health Nurse	7
Mother and Child**	7
Times Educational Supplement	6
Parents' Magazine	6
Practical Home Economics	6
Journal of Juvenile Research	6
Child Study	6
Journal of the National Education Association	5
Hygeia	5

* Formerly Kindergarten and First Grade.

** No longer issued.

Childhood Education is apparently the best single source for material dealing with nursery schools. Although a much younger magazine than Childhood Education,[2] Child Development is credited with nearly half as many references. Whereas the material appearing in Childhood Education deals largely with philosophy and educational procedures, Child Development reports only research studies.

Publications concerning the present movement for educating young children, the so-called nursery school movement, began to appear in 1919, although 50 per cent of the material has been published since 1929. Two trends in the field seem to be interrelated: descriptions of nursery schools as such have tended to disappear as the movement advanced, whereas researches have increased markedly. If these tendencies continue in the future, the time should be close at hand when nursery schools can be evaluated on an objective basis.

[2] Childhood Education was first published in 1924. The first issue of Child Development did not appear until 1930.

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Gross Metabolic Changes Characteristic of the Activity of the Neonate

T. W. RICHARDS

THE recent experimental interest in the subject of infant activity, notably by the students of Weiss at Ohio State University and latterly of Irwin at the State University of Iowa, has been confined largely to stimulus-response relationships. Pratt, Nelson, and Sun (22) investigated differentials of bodily activity in response to several stimuli, and Pratt (20, 21), Weiss (32), Stubbs (28), and Smith (27) have extended this work by way of refinement.

The study of the nature of the bodily activity of infants irrespective of specific external stimulus sources was the task of Irwin, who gave objective data regarding variations under relatively controlled conditions, originally with four infants during the first ten days (4) and later with newborns during one interval between feedings (5). The importance of time since feeding as a factor inducing bodily activity was demonstrated in these experiments. Pratt (18) obtained a very low correlation between the activity of the infant and temperature within the cabinet. Irwin (5, 6, 7) was able to show also that weight and several length and cephalic measurements of newborn infants at birth were unrelated to amount of activity shown on the stabilimeter, as were certain indices of nutritional status, body surface, and intestinal surface.

Certain studies of newborn infants in the field of metabolism wherein objective measurement of bodily activity has been made have provided a means of determining the relationship of other factors to bodily activity under fairly controlled external environment. It is the purpose of this paper to present certain reinterpretations of these data in so far as they may be pertinent to the study of bodily activity of newborn infants and its physiological concomitants.

That muscular activity is an important factor in heat production was recognized by the earliest workers in the field of metabolism. Rubner and Heubner (25, 26) emphasized its importance, and the classic work of Benedict and Talbot (1, 2) with infants took this factor into account. The conditions necessary for studies of basal metabolism of absolute rest and of fasting are, of course, impossible to control in the infant. Thus an indicator of relatively basal conditions of bodily activity was necessary.

Benedict and Talbot designed for this purpose a bed, the movements of which were transmitted to a kymograph and recorded objectively. Unfortunately they did not report the

amount of this activity together with their other physiological criteria for their 105 newborn infants (2), and a precise estimate of interrelationships with activity is impossible. They confirmed the findings of Rubner and Heubner that bodily activity raises heat production.

The most violent activity of the newborn infant, hard crying, may cause according to Benedict and Talbot an increase of 100 per cent in heat production. Extreme crying may raise it as high as 200 per cent above basal value. Murlin, Conklin, and Marsh (15) have calculated that the increase in metabolism incident to hard crying is roughly in proportion to the time spent in crying. Thus 1 per cent of the time spent in crying will induce a rise of 1 per cent in total metabolism, etc.

Benedict and Talbot believed pulse rate to correlate highly with bodily activity and with heat production. However, Murlin, Conklin, and Marsh, correlating pulse rate and heat production during basal periods for the infants of Benedict and Talbot, reported a coefficient of .276 ± .0043, and for their fifty infants a coefficient of .178 ± .0673. The coefficient for all periods for the Murlin, Conklin, and Marsh data was .374 ± .0372. It is thus not at all certain that pulse rate varies with heat production.

Both Benedict and Talbot and Murlin, Conklin, and Marsh measured body temperature and respiratory exchange in addition to heat production, bodily activity, and pulse rate. Murlin, Conklin, and Marsh used a bed recorder for measurement of bodily activity similar to that used by Benedict and Talbot. From the results of their study concerning all these indices we have taken the liberty of calculating the relation with heat production, using the Pearson coefficient. The results are as follows:

Items correlated	*r*	*P.E.*
Heat production* with pulse rate	.40	±.04
Heat production with respiratory quotient	.02	±.05
Heat production with body temperature	.14	±.05

* Heat production determined as calories per square meter body surface per hour; body surface determined according to Lissauer (14) formula:

$S = 10.3^{3}W^{2}$, where S = surface in sq. cm.
W = weight in grams, and 10.3 is constant.

Since these authors, like Benedict and Talbot, judged their activity records according to a point scale, activity was classified as basal, fretting, slightly restless, restless, and crying. For purposes of correlation we have calculated from these data, using the Yule formula, coefficients of contingency between activity on the one hand and heat production, body temperature, pulse, and respiratory quotient on the others. It should be kept in mind that the coefficients here are not strictly comparable to Pearson coefficients. They are as follows:

Items correlated	*r*
Bodily activity with pulse rate	.390
Bodily activity with body temperature	.433
Bodily activity with calories, square meter, hour	.455
Bodily activity with respiratory quotient	.281

From these coefficients it will be noted that bodily activity does not appear

to correlate highly with any other of these physiological indices.

Body temperature was found by Eckstein and Paffrath (3) to have no relationship to bodily activity, although they present no index of degree of correlation. Using a pneumatic system for recording bodily activity, they estimated activity from these records according to a point scale for hour periods. Irwin (6) found that body temperature (rectal, taken preceding the experimental period) correlated with oscillations per minute of the stabilimeter[1] gave a coefficient of −.02, while the temperature at birth gave a coefficient of .06, both insignificant. The degree of relationship (.433) calculated by us from the data of Murlin, Conklin, and Marsh would indicate some relationship. However, it should be kept in mind that in that study bodily activity was judged as being of one of five types for the whole experimental period and not measured per minute as in Irwin's experiments, so that fine variations are not considered.

These data regarding the relationship between body temperature and activity are of interest in connection with the physiology of temperature regulation. It has been generally accepted that bodily activity under conditions of low body temperature may in part be a reflex effect in an attempt to regulate body heat. To test this explanation one need only regard those cases in which body temperature is low and determine the extent to which bodily activity is greater than at other levels.

The average bodily activity in Irwin's (6) group of sixty-six infants, expressed in oscillations per minute of the stabilimeter, was 30. Three infants gave rectal temperatures of less than 98°F. preceding observation, as follows:

INFANT	RECTAL TEMPERATURE	OSCILLATIONS PER MINUTE
39	97.8	13.8
61	96.0	32.6
60	97.4	24.6
Mean.......	97.1	23.7

The infant with the lowest temperature was about as active as the average for the whole group, but the other two infants and the average of all three subthermic infants were below the average for the group in bodily activity. That these data do not bear out the theory that infants may respond to subnormal temperature by greatly increased bodily activity might be explained by assuming (1) that low bodily temperature is not always an index of low thermic stimulation to the infant and (2) that the lowest temperatures in this group may not be sufficiently low to elicit the regulatory response in the young infant.

Pratt (18) found a correlation between general activity as measured by the stabilimeter and temperatures of the experimental cabinet (ranging from 74° to 88°) of −.205 ±.024.

Although these experiments do not show relationship between temperature and bodily activity, it is nevertheless entirely possible that a group of infants under conditions of low temperature might in some cases respond by increased activity. The point deserves experimental attack.

[1] The stabilimeter recorded movements of a bed mechanically.

Jundell (9) showed that the curve of body temperature for infants is extremely irregular, but that by the age of two to five years it has assumed the diphasic character of that for the adult. It is in this way similar to the tendency for sleep and for bodily activity to evolve from daily polyphasia in the infant to diphasia in the adult, as shown by Szymanski (29). Thus, though temperature may not vary minutely with activity of the infant, its gross variations are physiologically related to those of activity over long periods.

TABLE 1

Percentages of group of Murlin, Conklin, and Marsh (16) in each activity classification, and the means and standard deviations for each in heat production, pulse, and respiratory quotient

ACTIVITY	CASES	PER CENT	CALORIES, SQUARE METER,* HOUR		PULSE		RESPIRATORY QUOTIENT	
			Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Basal	99	42.5	30.0	4.0	117.1	11.6	.83	.09
Fretting	13	5.6	30.3	5.6	124.5	7.6	.75	.06
Slightly restless	3	1.3	30.7	6.5	135.0	11.3	.84	.12
Restless	26	11.2	31.0	4.4	124.6	10.7	.78	.05
Crying	233	100.0	32.5	6.0	121.7	12.6		

* Lissauer formula.

In order to analyze further the relationship between bodily activity and the variables studied by Murlin, Conklin, and Marsh, we have determined the means and standard deviations in pulse rate, heat production, and respiratory quotient for each of the five types of bodily activity. These data are presented in table 1.

As a further check on the differences indicated by the mean heat, respiratory quotients, and pulse rates for these groups of newborn infants, we have also calculated the significance of differences between the amounts of each of the variables which occur during conditions of basal activity and crying. The results follow:

ACTIVITY	CALORIES, SQUARE METER,* HOUR	MEAN PULSE RATE	RESPIRATORY QUOTIENT
Basal	30.0	117.1	0.83
Crying	36.3	121.1	0.82
Difference	6.3	4.0	0.01
Critical ratio	7.9	2.2	1.00

* Lissauer formula.

Pulse rate appears to be suggestively higher during crying than when the infant is at rest. The respiratory quotient does not appear to change appreciably, but heat production increases decidedly over that under basal conditions when crying takes place. This difference is so marked that we have calculated the departure of these minimum values from the means of each of the other groups of activity. The maximum value of 36.3 calories per square meter per hour is significantly higher than those at each of the

other levels of activity. However, the levels of activity at basal, fretting, slightly *restless, and restless differ* significantly from each other.

A further examination of differences between the activity groups on the basis of respiratory quotient showed that the values of .82 given during basal conditions and of .83 given during crying are significantly higher than the quotients of .75 given during "fretting" and of .78 given during "restlessness." *This fact is difficult* to explain.

It should be kept in mind that the data of Murlin, Conklin, and Marsh discussed above are representative of all periods, irrespective of infant, time, or relation to other periods. If we select from the group those infants studied in two consecutive periods who showed a basal period followed by or following either another basal period or a period of activity, the following small groups are obtained:

> *Thirty-one infants gave two consecutive* basal periods;
> Eight infants gave a basal followed by a crying period;
> Seven infants gave a crying followed by a basal period;
> Three infants gave a fretting followed by a basal period;
> One infant each gave basal followed by slightly *restless and restless* followed by basal period.

Turning our attention only to the three first named groups, since there are so few in the other groups, we obtain the following results in terms of the differences in heat production during consecutive periods expressed in per cent of basal heat production:

PERIODS	MEAN CHANGE	PER CENT	
		Maximum	Minimum
Basal–crying......	+15.1	+51.9	0.0
Crying–basal......	−24.6	−39.6	−17.5

Since the first observation period, starting about *one-half hour after* feeding, might show the effect of the specific dynamic action of foodstuffs, it is important to note the differences in heat production in two consecutive basal periods. If we consider these data as percentages at the original basal period we obtain a mean change in the second period of −4.3, with a maximum of +25.2 and a minimum of −45.4. However, if we consider the data as percentages of the period of lower heat production, there is an average drop in the second period of −6.3 per cent, with a maximum of +25.2 and a minimum of −83.1. Thus, in the second of two basal activity periods, heat production drops some 5 per cent, so that if we attempt to correct the differences between basal to crying periods and crying to basal periods we increase the former difference from 15.1 per cent to about 20 per cent and reduce the drop from crying to basal periods from 24.6 per cent to about 20 per cent. Normally, crying seems to induce an increase of about 20 per cent of the heat production during basal periods when other factors are fairly controlled. It is interesting to note, however, that the average change during basal periods, when the direction of change is ignored, is an average of 9.5 per cent of the original heat production or 11.6 per cent of the lower heat production.

It is unfortunate that we are unable satisfactorily to determine the relationship between the metabolic factors of heat production and respiratory quotient with respect to time since feeding. Many factors tend to confuse clear-cut results in this respect. Levine, Wilson, and their coworkers (12, 13) have shown that by means of the specific dynamic action of foodstuffs basal metabolism may be raised by milk diet 4 to 9 per cent, by fat 1 to 8 per cent, by protein 15 to 17 per cent, and by glucose 8 per cent in normal infants three to four months of age.

Another factor which prevents clear-cut deductions of variations in heat production with time since previous feeding is that sleep, which is characterized by definitely lowered heat production, may occur at practically any time with respect to feeding and by most observers is noted particularly immediately after feeding.

Talbot (30) has published results obtained from two infants, aged three and six months, observed for practically all of the twenty-four hour period. His results for respiratory quotient, pulse, and Gr. CO_2/Kg./Hr. are plotted in figure 1. Feeding periods are indicated by perpendiculars bisecting the curves at various intervals. It will be observed that the respiratory quotient with these two infants tends to drop during the period between feedings. Pulse rate seems slightly to increase, particularly during the longer periods, while CO_2 expired seemed to vary relatively independently of time since feeding. It will be seen that, with the exception of the pulse rate of the six months infant during the period from 7 P.M. to 6 A.M., both pulse and CO_2 expired seem to be greatest in active periods as indicated in figure 1. If these results with two infants mean anything for comparison with the newborn, it might be concluded that pulse and CO_2 expiration may vary with time since feeding. This increase in activity is not as yet clearly demonstrated in heat production nor in respiratory quotient, due to factors of sleep and "specific dynamic action" of foods.

Lesne and Nattan-Larrier (10, 11), using the apparatus of Plantefol (17), have recently reported data on CO_2 output of infants for hourly intervals after feeding. Mean values of L. CO_2/Kg. B.W./Hr. were as follows:

Interval, hours	*Mean*
½ to 1½	.50*
1½ to 2½	.49
2½ to 3½	.48

* The mean deviation from the mean of these values is reported to be about 5 per cent.

From this and other work on the relationships of metabolic factors to bodily activity on the one hand and to time since previous feeding on the other, it seems fair to conclude that among these metabolic variables there is no one index of physiological activity which corresponds at all times to muscular activity as measured by the stabilimeter. Muscular activity is a factor in raising heat production over the basal requirement, but other factors are also important. The specific dynamic action of foodstuffs is sufficient to raise heat production by a sizeable amount. Sleep, which is reported by many investigators to be

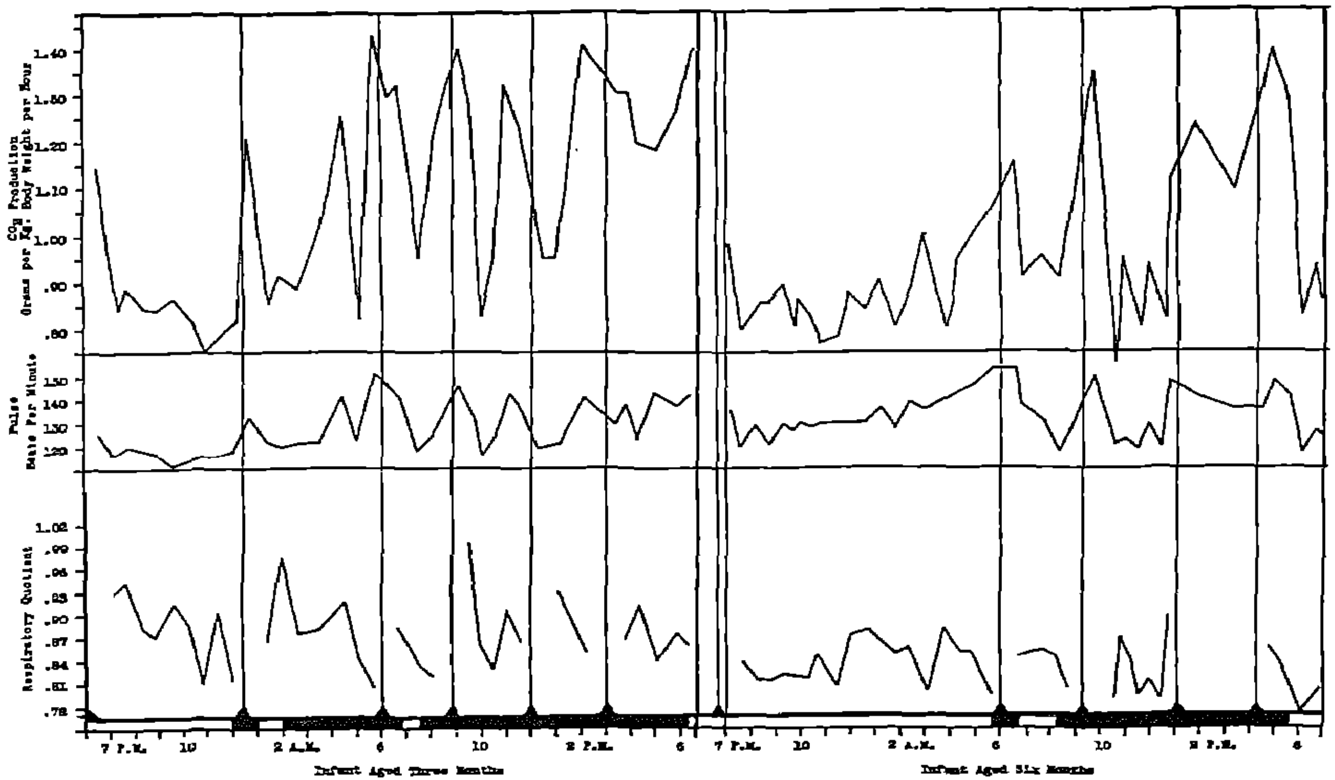

FIGURE 1. DIAGRAM ILLUSTRATING CO_2 PRODUCTION, PULSE RATE, AND RESPIRATORY QUOTIENT OF TWO INFANTS OVER A TWENTY-FOUR HOUR PERIOD

Meal periods indicated by perpendiculars erected from triangle. On base line: Solid indicates periods of "activity," *cross* hatch indicates "awake but quiet," and white indicates "sleep." From data of Talbot (30).
Converted into Gr. CO_2/Kg. B.W./Hr. by the author.

most prominent soon after feeding, has been shown to reduce total heat production, as one would expect from the fact that in the infant what is judged as sleep is in some measure the reciprocal of muscular activity. The heat production subsequent upon growth, though important at this level, is a factor which would not greatly affect results at any one restricted age level since it should introduce a constant increase. Thus we may assume that if basal metabolism might be accurately determined at the level of the newborn infant and if heat production incidental to specific dynamic action of foods and possibly to growth were held constant (i.e. through control of feeding, difficult with breast fed infants), the degree to which heat production is increased over the basal value would correlate highly with muscular activity as indicated by the stabilimeter. A relationship might obtain between a similar ratio of increase in respiratory quotient. Here, however, not only the specific dynamic action of foodstuffs but the extent to which O_2 is required to oxidize them to end products of CO_2 and H_2O is a factor, and the ratio of fat to carbohydrate would need to be held constant. In addition, an indication of protein metabolism by measurement of urinary nitrogen would be necessary. Body temperature, excepting perhaps under extreme conditions, is not related to bodily activity.

It was mentioned early in this paper that Irwin (5) correlated the von Pirquet (16) index of intestinal surface (area of intestine = (sitting height)^2) with bodily activity, obtaining a coefficient of $-.02 \pm .08$. Regarding this finding, it might be supposed that bodily activity estimated as oscillations of the stabilimeter per unit time would not be expected to vary with intestinal surface so much as would the acceleration in bodily activity only during the early part of the past feeding period. The blood sugar curve of Winter for infants (33) shows that maximum carbohydrate has been absorbed from the intestine by sixty minutes after feeding. Thus as intestinal surface presumably affects rate of absorption, the time necessary for maximum blood sugar to appear in the blood should correlate with intestinal surface, and it would be interesting to see whether or not each of these indices would correlate, not so much with bodily activity, but with the degree of acceleration of bodily activity subsequent upon feeding.

SUMMARY

Muscular activity in the infant appears definitely to raise heat production. Although it was earlier believed that heat production varied with pulse rate to some extent, examination of data shows the degree of correlation to be but .28 during periods of inactivity, and but .37 to .40 for all periods. Pulse rate correlates slightly with muscular activity for all periods, again with a coefficient of about .40. When heat production and muscular activity for all periods are correlated, a coefficient of .46 is obtained.

Respiratory quotient appears to vary somewhat independently of both heat production and muscular activity.

Body temperature varies quite independently of heat production and

seems related slightly if at all to muscular activity. Environmental temperature seems also to be slightly related to bodily activity.

When very active (crying) infants are compared with inactive infants, a significant increase in heat production is found. This increase on occasion has been claimed to be as high as 200 per cent over basal heat production. Between consecutive periods of heat measurement on the same infants, crying may induce an average rise of 20 per cent in heat production when specific dynamic action is partialled out. A slight increase in pulse is also engendered by extreme bodily activity. No difference between crying and inactive infants is noted in respiratory quotient.

We might conclude from these data that there is at present no one index of physiological function which seems highly related to bodily activity. Muscular activity may be considered not only as an expression of the nutritional state of the organism, as pointed out elsewhere (7, 19, 23), but as a factor contributing toward total heat production of the organism. Acquaintance with more subtle physiological variables, as yet but little understood, may lead ultimately to an understanding of the organic determinants of variations in infant behavior.

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Laterality of Function in Early Infancy under Controlled Developmental Conditions[1]

WAYNE DENNIS

INTRODUCTION

WHILE the data on handedness are now extensive, the facts concerning this phenomenon in the period of early infancy are still meager. The need of a larger number of developmental studies such as the ones conducted by Baldwin and Woolley (1, 20) is quite apparent.

I have recently reported an experiment upon the effect of restricted social stimulation and of restricted practice upon the behavioral development of two infants. At an early period in the conduct of this study it was decided to incorporate as a part of the experimental routine some precautions against differential treatment of the two sides of the body. These provisions made it possible to obtain another record of handedness and of related aspects of behavior under controlled developmental conditions.

SUBJECTS AND PROCEDURE

The subjects of the investigation were non-identical female twins which were reared under a controlled regimen from the 36th to the 428th day of life. Mrs. Dennis and I assumed their entire care. The general routine of procedure has been described elsewhere (5, 6) and it is necessary here to describe only the precautions which, beginning on day 48, were taken to prevent favoritism of either side of the body on our part.

The infants spent almost their entire time in two Kiddie Koops, 40¼ inches long, 24½ inches wide, and 20 inches deep, which were placed side by side but which were separated by an opaque screen of the same height as the cribs. Because of this arrangement one crib had to be approached on the right side and the other on the left side. At an early date this led to a laterality in the behavior of the infants which will be described later, and this in turn caused us to adopt the following practices.

In order to avoid as completely as possible any unequal treatment of the two sides, beginning with day 48 each baby was alternated daily in respect to the bed which she occupied. This not only caused us to approach each infant the same number of times from either direction but it also prevented the possibility that laterality preferences might arise through either twin

[1] Acknowledgment is gratefully made to the Institute for Research in the Social Sciences at the University of Virginia for defraying the expenses of the research here reported and to Mrs. Dennis for her invaluable coöperation and assistance.

turning toward the other's crib. Furthermore, the environments of the infants were identical to the extent that the subjects spent the same amount of time in each of the two cribs.

At the beginning of the experiment each subject was fed by placing the bottle of milk upon a small pillow by her head. The subjects faced in opposite directions in nursing as shown in figure 1. On day 48, however, we began to take each subject in arms for feeding. Each baby was placed on the experimenter's lap and supported by the experimenter's left arm. The feeding bottle was held in the experimenter's right hand, but care was taken to hold the infant so that her arms would not be unequally restrained. The nursing bottle was held straight in front of the baby. When the feeding of solid foods was begun, the foods were given from a spoon which was held in the experimenter's right hand but which was advanced to the mouth from a position judged to be directly in the median line of the subject. In administering stimuli, too, and in offering toys, we again tried to avoid asymmetrical treatment of the subjects, although the experimenter's right hand was always used.

One may rightfully doubt whether unequal treatment of the two sides of the body was really avoided when care was administered in the right-handed fashion described above. However, the data to be presented have certain characteristics which it seems unlikely could have resulted from our own behavior.

The subjects were fed simultaneously, Mrs. Dennis feeding one and I feeding the other. Since it is likely that our techniques differed slightly, although unintentionally, we alternated daily in the feeding of the babies; that is on one day Mrs. Dennis fed Del and I fed Rey, on the next day Mrs. Dennis fed Rey and I fed Del, etc. In other matters, too, such as in changing diapers and in bathing, the attentiveness of each experimenter was given equally to the two subjects.

RESULTS

A head turning habit. Since no effect of the method of feeding first described above was anticipated, the earliest appearance of a turning habit may have been overlooked. The habit was first noticed on day 46, or after the babies had been fed for 10 days five to six feedings per day in the manner outlined above. On this day it was observed that each baby during a large part of the time held her head in the position which she maintained in nursing.

In order to find whether this might be due to a peculiarity of the bedding, etc., Rey was placed in crib B and Del was removed to crib A not long after the early morning feeding. Figure 2 shows the result. The original direction of the head was maintained, so that each infant turned away from the appropriate feeding point of the crib which she now occupied.

At the next feeding hour, 11 A.M. these positions were maintained even when the bottles were held in the usual places. That is, each infant turned in a direction which now caused her to face away from the bottle. The infants were sufficiently hungry that the

situation caused them to cry. The screen between the cribs ruled out the possibility that either infant was visually directed by the wrong bottle.

These positions were held so consistently that each infant had to be turned on her side toward the food and held in this position in order to get her started to eating. While nursing, each baby gradually returned to the supine position, keeping her head turned in the new direction.

The placement of babies in the cribs as indicated by figure 2 was maintained after this feeding. Unfortunately no further records of head positions were taken until the next feeding hour,

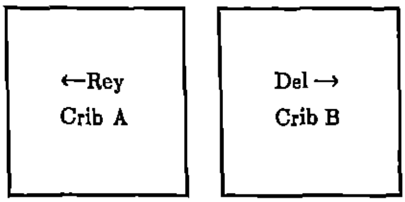

FIG. 1

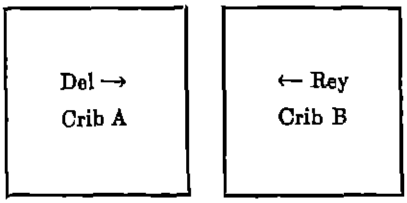

FIG. 2

3 P.M., day 46. At that time, Del was correctly turned when the bottle was offered; Rey first turned to the wrong side as she had done four hours earlier, but was more easily corrected than she had been on the preceding occasion.

The situation shown by figure 2 was retained throughout day 46, but no further errors in turning for food were seen.

Before the 11 A.M. feeding on day 47, each infant was returned to her original crib as shown in figure 1. Del immediately turned toward the bottle; Rey, however, continued to turn in the direction which had been correct the immediately preceding day, although that direction was now incorrect. When she persisted in her error and obtained no food, the nipple was placed in her mouth and the experimenter slowly pulled the bottle to the new position. The situation shown in figure 1 was maintained during day 47. At 3 P.M. of this day no error occurred with Rey, but at 7 P.M. the behavior noted at 11 A.M. was approximately duplicated. Upon both of these occasions Del's behavior was apparently controlled by the position of the bottle, as noted earlier on this day.

As we deemed it desirable to avoid the formation of habits of sidedness we began at this time to take each subject in arms for feeding, as described previously. Thus the position habit in feeding was brought to an end at this point.

Movie study. A movie study has shown that upon detailed analysis differences in activity on the two sides of the body were discernible in responses to certain stimuli which were administered between days 48 and 81, (8). The data of the movie study are too extensive to be reviewed here. The present report deals only with asymmetrical patterns of behavior which were observable without the aid of a recording device.

Nursing posture. The first pat-

terned response to show a definite asymmetry was the feeding posture. A brief report on the postures of defecation and of nursing in these subjects and in several premature and normal-term newborn infants has already been presented (4). The nursing response of each infant when she first came under observation may be described as follows: During nursing and also during the abdominal strains of defecation, the forearms were hugged tightly to the chest with the fists near the neck. The legs and toes were extended and when the infant was on her back the lower extremities were often raised slightly off of the supporting surface. The response did not occur in the feeding situation if the infant was not hungry or if she was very sleepy, and did not appear in the case of elimination if the feces were soft or watery. *Up to day 70 the* nursing posture as described above was recorded 157 times, distributed about equally between the two infants. The only feeding posture apart from the one just described which was seen during this period was exhibited by Rey alone and it later became her characteristic nursing posture. Within this same period 32 defecations were witnessed and in 29 of these the previously described pattern was seen. Of the remaining three instances of defecation, two occurred without associated limb movements and in the remaining case, that of Del, one forearm was extended by the side instead of being drawn up to the chin.

In accordance with the above description it is seen that the nursing posture and defecation postures were bilaterally symmetrical up to about day 70. Thereafter each infant began in connection with nursing to display a variation in the response, which made it asymmetrical.

In Rey's case the modification consisted in rigidly holding one of the forearms parallel to the mid-line of the head with the elbow straight out from the shoulder. In the third and fourth lunar months Rey did this with only one arm a total of 69 times, the other arm keeping the position indicated by the original description. She never did it with both arms in this period. In 88 per cent of the cases the arm which performed the new response was the right arm. In later months this response came to be predominantly bi-manual and hence again asymmetrical, but on the occasions on which it remained unimanual the right hand held the position in approximately *the same proportion of the cases as had* been the case in the earlier asymmetrical responses. After the 7th lunar month Rey's nursing posture gradually disappeared.

Del's new feeding posture consisted in extending one or both arms at her side, parallel to the body. The arm or arms were actively extended, not merely relaxed in this position. Within the first seven lunar months this new response was observed on 89 occasions, on 95 per cent of which it involved only one arm. In all but 6 cases this was the left arm. In later months Del, too, gradually ceased to keep any definite posture during feeding. Even before the appearance of asymmetry in the nursing posture was observed, the act of defecation had ceased to involve the arms in any stereotyped manner, so that laterality

could not be observed in that connection. The legs continued to extend during defecation for many months, but almost invariably this was a bilateral response.

Time sampling observations. In addition to the nursing posture, it is possible that other patterned activities such as sucking the fingers and rubbing the face involved a definite hand preference during the first six months, but our casual observations of these responses were too few to establish the point. For that reason we began in the seven lunar month a series of time-sampling studies. Following, many of the feeding periods of the 7th 8th, 9th, 10th and 11th lunar months we observed and recorded behavior systematically, noting which limbs were involved in each response. In making this observational study we sat at the foot of the cribs and about four feet from them, in a position which made us invisible to the babies. The babies lay on their backs in the cribs and were uncovered and without toys of any kind. Time was kept by a stop-watch. On each occasion upon which observations were taken, we observed for 15 seconds, recorded for 15 seconds, observed for another 15 seconds, etc., until twenty such recording periods were completed.

The results with respect to side preference are shown in table 1. The table is constructed as follows: Under the heading N is shown the number of instances which were observed. The variation from month to month in N does not reveal changes in the subjects as the number of observational periods per month was not held constant. The heading "%U" shows the per cent

TABLE 1

LUNAR MONTH	RUB FACE						HAND TO MOUTH						SCRATCH SHEET, CRIB, ETC.					
	Rey			Del			Rey			Del			Rey			Del		
	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R
7th	82	39	35	114	83	99	30	74	34	220	86	74						
8th	151	41	52	78	96	93	88	82	42	185	86	81						
9th	39	62	33	50	98	98	53	87	28	108	70	55	33	100	90	27	100	96
10th	47	64	60	60	98	98	68	91	14	184	73	50	33	100	55	39	100	33
11th				21	100	96	40	97	0	82	65	47	22	100	18			

LUNAR MONTH	ARM ACROSS FACE						SUCK HAND			WAVE LEG			FOOT RAISED AND GRASPED		
	Rey			Del			Rey			Rey			Rey		
	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R
7th				37	100	100							65	42	41
8th				46	100	100	22	95	23	19	100	0	75	32	46
9th	48	85	95	43	91	100	32	100	0	40	100	0	181	64	45
10th	28	100	100	30	60	84	140	100	8	84	100	0	195	75	60
11th				24	80	96	43	100	0	37	100	11	113	81	53

of instances in which the behavior was unilateral, and the heading "%R" shows the per cent of the unilateral responses, not of the total responses, which were performed by the right side of the infant. Any significant deviation of the R scores from the chance expectancy of 50 per cent indicates therefore a side preference.

Several characteristics of the data contained in the table may be mentioned. Firstly, the degree of unilaterality varied greatly among the different patterns of activity. For instance, in the case of each subject the act of scratching the screen of the crib was invariably a unimanual activity, whereas rubbing the face was often engaged in simultaneously by the two hands. With Rey, the degree of bilaterality even in the use of the legs depended upon the type of activity engaged in.

Secondly, among hand activities the side preference of Rey at certain months varied with the response. In the ninth month, Rey was left-handed in rubbing the face, and in "hand to mouth" response, but right-handed in scratching and in arm-across-face, the latter indicating sleepiness. She later became left-handed in scratching but never became left-handed in hand-across-face behavior. Del was somewhat more consistent in hand-preference, preferring her right hand in most activities, but she used right and left hands about equally often in putting fingers to her mouth. It will be recalled that Del's left hand was the first to change its rôle in the nursing posture.

Thirdly, the records of the two subjects are different in two respects. The infants had opposite preferences in respect to rubbing the face. With reference to hand-to-mouth, Rey showed a pronounced left preference and Del exhibited scarcely any preference at all. In the other two activities shown here their records are somewhat similar. It will be noted that Rey engaged in three activities which were practiced so seldom by Del that her record is not included in the table. The differences between the two subjects seems to show that the preferences were not unwittingly imposed by us through our care, for had the preferences been forced upon the infants it seems unlikely that the two subjects would have differed.

Reaching. Between the 11th and 15th lunar months we conducted a number of reaching tests with a dangling ring, a rattle, and the nursing bottle. The dangling ring was held within easy reach directly in the median plane as the baby lay in her crib. The ring was removed from her hand soon after she grasped it, and another test was made almost immediately. Usually about ten such tests were made at one "sitting." The tests became somewhat of a game and the babies did not object to the removal of the ring.

The rattle was presented in a similar fashion except that the infant was placed in a high-chair for the test and the rattle was put on the tray of the chair in the median plane of the subject and within easy reach.

Tests with the nursing bottle were made at the routine feeding times, the nipple being withdrawn from the mouth and held directly in the median plane of the infant and within easy

reach until she replaced it by her own efforts. Not more than five tests were made at one feeding.

The results of these tests are shown in table 2, which is constructed in the same manner as table 1.

The table shows that these responses were predominantly unimanual. In Del's case, they were almost exclusively so. The unimanual actions of Del in these situations were carried out by the right-hand in 100 per cent of the cases, in a total of roughly 500 tests.

Rey at the start was left-handed in reaching for bottle and rattle and ambidextrous in grasping the ring but she changed in the direction of greater preferences for her right hand in all of the activities during the course of the experiments. However, the changes in hand preference in different activities did not occur at the same time. During the 13th month she was somewhat right-handed in reaching for the dangling ring but she was still pronouncedly left-handed in reaching for the bottle and the rattle. In no situation did she ever use either hand to the total exclusion of the other as did Del.

Rey underwent temporary changes in handedness which are not revealed by these tables because the data are grouped by months. A great many trials with the dangling ring were given on day 351 and a large number of tests with the rattle were made on day 358 in violation of the usual rule of administering no more than 10 tests at a time. On the former day she reached 24 consecutive times with her right hand, then 8 consecutive times with her left, 9 more with her right, 3 with her left, and finally 6 with her right. On the latter day she reached 18 consecutive times with her left and then 8 consecutive times with her right. It goes without saying that the probability that divisions of this sort occurred through chance is extremely small. Franz (10) has reported somewhat similar shifts in handedness in monkeys.

TABLE 2

LUNAR MONTH	GRASP DANGLING RING						GRASP BOTTLE						GRASP RATTLE					
	Rey			Del			Rey			Del			Rey			Del		
	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R	N	%U	%R
11th	90	00	53	92	95	100	54	100	0	64	94	100						
13th	70	98	71	25	100	100	101	92	4	107	100	100	46	100	20	58	100	100
14th							22	100	0	25	100	100						
15th							240	94	82	148	100	100	54	100	72	37	100	100

Restraining the preferred hand. Because Del had never used her left hand in the reaching tests though she did use her left arm on other occasions, we tested her with the nursing bottle on day 408 with her right hand enclosed inside the sleeping garment, a Dr. Denton garment, which she wore at the time. The right arm was withdrawn from the sleeve and the garment was buttoned over the arm. This gave her arm some freedom but it was

impossible for her to reach the bottle with it.

On the first trial she attempted to reach with her right hand as usual and when she failed she cried. She tried to reach the nipple by bending her head forward, but did not make any effort with her left hand. After she had cried for a minute the nipple was placed in her mouth to quiet her.

After about 30 seconds the nipple was again withdrawn and was held in the position which it usually occupied during the tests. She repeated her first performance with respect to trying to reach with her right hand, trying with her mouth, and then crying. She finally grasped the nipple with her left hand, though she usually grasped the bottle, not the nipple, but did not pull it toward her mouth. Again the bottle was given to her.

On the third trial she attempted to reach with her left hand almost immediately but did not succeed in grasping the bottle in 30 seconds of effort.

This striking deficiency of the unpracticed hand, showing as it did a very imperfect cross-transfer, deserved further study but unfortunately the final three weeks of the experiment called for so many other observations and tests that the proficiency of Del's left hand was not pursued further. When she was given an opportunity to reach with her right hand at the next nursing period, she immediately resumed her use of this hand.

Other preferences in the fourteenth and fifteenth months. During the last months of the experiment, Rey was not consistently right-handed even though she preferred her right hand at this time in all of the responses which occur in table 2. She used her right arm in raising herself to a sitting position in 57 of 58 instances which we observed in the 15th month, and her right hand held her foot in all of 23 records of this response. However, it was the *left* foot which was held in 19 of these instances, and it was her *left* thumb which was in her mouth in all of the 24 cases of thumb sucking which were recorded in the fifteenth month.

Del, on the other hand, was still consistently right-handed in practically all of her activities which came under our notice. These actions were: pushing the bottle away when she had finished eating, 51 cases, all R; fingering her lips in sound play, 38 cases, all R; patting herself on the chin, 38 cases, all R; rising to sitting by pushing with her arm, 94 cases, all R; and putting her foot on the tray of her high-chair, 17 cases, all R. She rolled from her back to her abdomen with roughly the same frequency by way of either side in a total of 53 cases, although in going from supine to prone she always turned on her right side, 42 cases.

DISCUSSION

1. It may be noted first that the incidental observation of a head turning habit which led us to be especially careful in our care of the infants shows that asymmetry of function may at a very early age be the result of the manner in which the adult cares for the infant. There seems to be no doubt that the head turning phenomenon was a true habit and that it was due to the manner in which the babies

were fed. However, it quickly disappeared under appropriate procedure.

2. On the other hand the data show that pronounced laterality preferences may develop when precautions are taken to avoid training that favors either side. Handedness need not be conceived of as a mere tradition or a "culture trait." This study agrees with the investigations of Baldwin (1) and of Wooley (20). Each of these authors found that handedness appeared in a child which was reared with the intention on the part of the parents to avoid influences prejudicial to either hand. There is, of course, the question as to whether the investigators succeeded in carrying out their intentions. In the present instance the differences which appeared between the two subjects tend to indicate that there was no general imposition of handedness by the experimenters.

3. The data here presented show that high dextrality and sinistrality are possible at an early age. Studies by Jones (13) and others (14, 17) show that dextrality increases with age when the records of a few tests on each of a large number of children are totalled. These studies do not reveal with much reliability the condition of any individual child because only a few tests were administered to any one subject. That individual cases may be very unlike the general trends is suggested by the fact that both Del and Rey were almost 100 per cent dextral in many activities from seven months of age onward, and possibly even at an earlier age.

4. The change in handedness in certain activities which Rey underwent is a common but not a universal phenomenon. It is recorded in the biographical studies of Wooley (20), Darwin (2), Major (15), G. Stanley Hall (11), Myers (16) and Dearborn (3) and doubtless in still other accounts as well. Needless to say, Rey's changes were not accompanied by any disturbances of vocalization in so far as we could observe, and some of the writers referred to above also call attention to the fact that spontaneous changes in handedness produce no effect upon the language mechanism.

5. *Specificity of Handedness.* In respect to theories of handedness, the most important aspect of the present study is the proof of the specificity of early laterality preferences, which is abundantly provided by the data which have just been presented. Explanations of handedness have usually assumed that handedness is a general trait. In light of the data summarized by Downey (9) in her review of laterality of function it now seems that these explanations are in the embarrassing situation of having explained "facts" which do not exist. For there is a wealth of material to show that hand preference is dependent upon the action which is performed and upon the situation in which it is performed.

But the advocates of a simple theory of handedness, such as the "dominant hemisphere" theory, can suppose that while handedness is *natively* a general trait the demands of civilization may cause a man to write with one hand but to throw baseballs with the other. These advocates, however, will find it extremely difficult to account for a specificity of handedness such as occurred in both subjects of the present investigation on the basis of social

interference with a native general handedness.

The data on the twins do not stand alone. Baldwin found his daughter to be ambidextrous in reaching for near objects but right-handed in executing long reaches. Wooley noted with reference to her child that at an age at which he reached predominantly with his right hand, he preferred his left-hand in waving bye-bye. Valentine (18) reported that left-handedness in reaching for wools was not accompanied by a similar preference in other activities in his subject, for his son used the right hand exclusively in thumping the piano at the time of Valentine's study.

One may be able to bolster up the theory of a general hand preference in the above cases by supposing that the non-preferred hand was used in some activities because the preferred hand was reserved for possible concomitant actions which were more dominant. Whether this is the true explanation might be put to an experimental test. Meanwhile it seems advisable to call to the attention of theorists the possibility that handedness may be specific from the beginning. Is there anything absurd in the notion that the bones, muscles, tendons, joints and nerves of a particular infant may be so constructed that the right is the more suitable for the grasping of one type of object and the left for grasping another kind of material? I see no obvious absurdity in this explanation of preferences such as Rey's.

Is it also not possible that a difference in structure sufficient to cause a laterality preference in a certain activity may lie anywhere in the involved sensory-neuro-motor arc, in sense organs, in muscles, in bones, in tendons, in joints, as well as in nervous tissue? Valentine and Wagner's demonstration of handedness in the newborn (19), whose cortex is probably non-functional, shows that not all bases of preference are located in the cortex, as often seems to be assumed. In anatomical research, slight asymmetry of structure is found in all parts of the body, not merely in the cortex. This fact suggests that a single-cause explanation of handedness is an unreasonable one from the start.

SUMMARY

This report has dealt with the laterality aspects of the behavior of two infants who, to the best of the experimenter's ability, were guarded from an early age from incidents which might be expected to lead to a side preference in any activity. It has been shown that laterality preferences developed, nevertheless, and that they were often unlike in the two infants. It seems necessary to conclude that they were not socially transmitted. Further it has been pointed out that the study shows the possibility of a very high degree of dextrality from the seventh month onward. Nevertheless, dependence of laterality preferences upon the situation and upon the particular response characterized the data of the entire study. From this fact, and from other considerations, it is suggested that the assumption that handedness is a general trait and the assumption that hand preferences are due solely to asymmetrical structure of the cortex are unjustified and that a single cause explanation of all

hand preferences is unlikely to be correct. The preceding statement is in terms of *manual* laterality because discussions and researches have so often stressed the handedness aspects of asymmetrical function, but the argument is meant to apply to other kinds of sidedness as well.

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The Movement Response of the Human Fetus to Sound Stimuli

Lester Warren Sontag and Robert F. Wallace

In a preliminary report of their work on human fetal behavior, Sontag and Wallace described the muscular responses of the fetus to certain sound stimuli. Since the publication of that report, considerable progress has been made in the accumulation and interpretation of data on this subject. The results of these further experiments are presented here because we feel that they add something to the existing understanding of the physiology of the unborn child. While the phenomena of the response of the human fetus to sound stimuli has previously been reported by Forbes and Forbes (1), Peiper (2), Ray (3) and others, these reports are observations in the main, more or less occasional observations and are not suitable for statistical analysis. In no instance have these investigators attempted to determine the time of onset of this response, its reliability or its changes with increased fetal age.

METHOD OF OBSERVATION

A mechanical arrangement for recording the movements of the human fetus has previously been described by Sontag and Wallace (4). The device consists of a set of four rubber sacks encased in a cloth container, which fits over the maternal abdomen. A plaster of paris cast, fitting snugly the contour of the abdomen, is placed over the rubber sacks and is held in place by a muslin binder which passes entirely around the trunk of the mother. Each of the rubber sacks is connected by a thick-walled, small bore tube to one of a set of four tambours. Each tambour in turn, activates a pen. By this means tracings of all abdominal movements are recorded on a moving ribbon of paper. Respiratory movements can be differentiated from fetal movements by reason of the fact that they cause a synchronous displacement of all four pens, while a movement of the fetus causes a change in shape of the uterus and, therefore, a decrease in pressure in at least one sack necessarily accompanies the increase in pressure in the sack against which the fetal member is being pushed. The resulting record shows a rise in one or more of the pen lines during a fetal movement, which is always accompanied by a lowering of one or more of the other lines.

In our first studies of fetal movement this recorder was used together with the recording of subjective sensations of movement indicated by the mother. The mother indicated such sensations by means of a small incandescent bulb which could be lighted by pressure on a push-button which she held in her hand throughout the

period of observation. Checking of the early records showed a high degree of reliability of the subjective records as compared with the records taken on the fetal movement recorder. Since we wished to listen to the fetal heart during the records, the fetal movement recorder was not used for collection of the data presented here. The record of the sensation of movement as indicated by the mother was used exclusively.

Sound stimuli were applied by means of an ordinary door bell buzzer whose knocker instead of striking a metal bell, was made to strike a small wooden disc which was in contact with the abdomen. When the sixty cycle current was turned into this device, a loud knocking sound was transmitted through the wood block directly to the skin of the mother's abdomen. The sound block was routinely placed over the fetal head, as responses were much more constant when this precaution was taken than when the sound was applied elsewhere on the abdomen. Other sound frequencies were tried, but, either because of differences in the means of applying them or because of the difference in their vibratory frequency, they did not produce a reliable fetal response.

TABLE 1

Comparison of the number of fetal movements per minute before and after auditory stimulation by weeks and months prenatal. Eight patients—195 records

MONTHS PRENATAL	WEEKS PRENATAL	NORMAL FETAL MOVEMENTS PER MINUTE		NUMBER OF FETAL MOVEMENTS PER MINUTE AFTER STIMULATION		CHANGE IN MOVES PER MINUTE WITH STIMULATION		NUMBER OF RECORDS	
		Weekly	*Monthly*	*Weekly*	*Monthly*	*Weekly*	*Monthly*	*Weekly*	*Monthly*
1	1	0.80	1.42	3.16	2.76	2.36	1.34	31	91
	2	1.52		2.23		0.71		30	
	3	2.16		2.87		0.71		15	
	4	1.73		2.93		1.20		15	
2	5	1.79	1.38	2.33	2.09	0.54	0.71	15	53
	6	1.77		2.31		0.54		13	
	7	0.44		1.22		0.78		9	
	8	1.23		2.10		0.98		16	
3	9	0.93	1.15	2.21	1.49	1.28	0.30	14	51
	10	1.25		1.37		0.12		19	
	11	1.32		1.31		−0.01		13	
	12	0.68		0.40		−0.28		5	

EXPERIMENTAL DATA

A total of 214 experiments were made on the seven patients used. Observations ranged from 127 to 1 day before birth. All of the 214 cases are used in table 3. Only 195 of them are used in tables 1 and 2 because the remainder of the 214 were made earlier than three months before the birth of the infant. The infants upon whom experiments were made, delivered from 255 to 288 days after the date of the last menstrual

period. They ranged from 2387 grams to 3454 grams in weight.

Each observation period lasted exactly fifteen minutes with the exception of 12 on one patient which were ment was divided into minutes and the number of movements in each minute were recorded. In a second treatment of the data each minute was classified as active, if one or more

TABLE 2

Comparison of per cent of time active of the human fetus before and after auditory stimulation by weeks and months prenatal. Eight patients—195 records

MONTHS PRENATAL	WEEKS PRENATAL	NORMAL PER CENT OF TIME ACTIVE		PER CENT OF TIME ACTIVE AFTER STIMULATION		CHANGE IN PER CENT OF TIME ACTIVE AFTER STIMULATION		NUMBER OF RECORDS	
		Weekly	Monthly	Weekly	Monthly	Weekly	Monthly	Weekly	Monthly
1	1	44	49	94	86	50	37	31	91
	2	47		93		40		30	
	3	55		87		32		15	
	4	60		77		17		15	
2	5	48	51	93	81	45	30	15	53
	6	69		85		16		13	
	7	31		56		25		9	
	8	51		81		30		10	
3	9	44	51	64	57	20	6	14	51
	10	52		63		11		19	
	11	60		54		−6		13	
	12	44		20		−24		5	

TABLE 3

Showing the number of fetal movements per minute and the per cent of time active for each of the seven patients

NUMBER OF CASES	A 11	B 23	C 23	D 13	E 66	F 69	G 31
M.P.M. normal	0.72	0.83	1.20	1.07	2.13	1.17	0.70
M.P.M. after stimulation	1.00	0.61	3.09	2.58	1.84	1.85	3.42
Change	1.18	−0.22	1.80	0.01	−0.29	0.68	2.72
Normal per cent of time active	30	39	45	53	69	54	42
Per cent of time active after stimulation	70	47	83	92	68	69	100
Change, per cent	40	8	38	30	−1	15	58

carried over a half hour period. The fifteen minute periods were divided into a five minute control period and a ten minute period following the sound application. The time of each experi- movements occurred in it, and inactive if no movements occurred in it. An attempt to compare the extent or degree of one movement to that of another was unsuccessful.

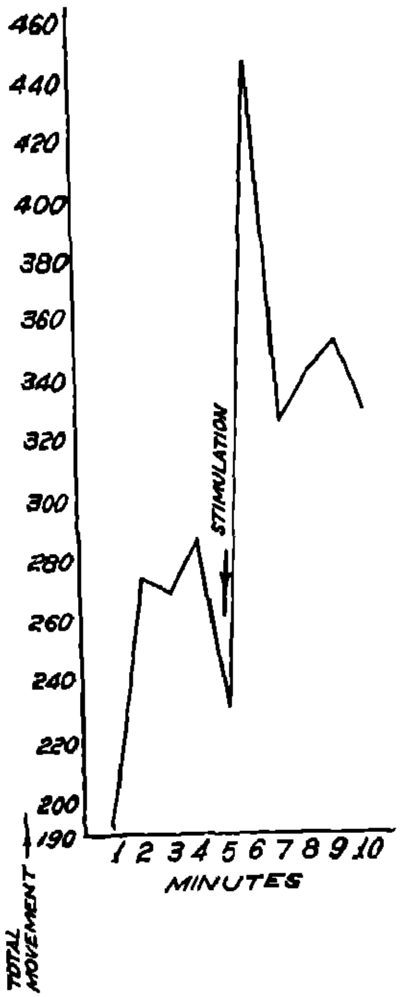

FIG. 1 FETAL MOVEMENT
Five minutes before and five minutes after sound stimulation, showing number of moves per minute before and after stimulation. From 1 to 127 days prenatal. Average 40 days prenatal.

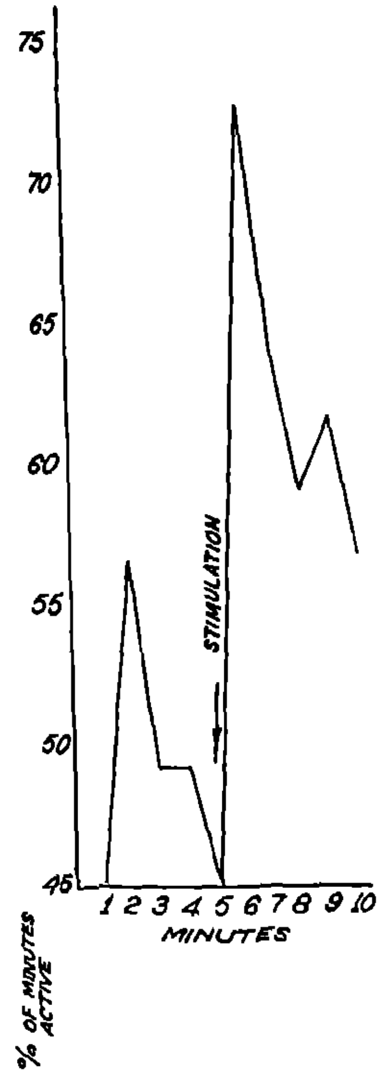

FIG. 2. PERCENTAGE OF ACTIVE MINUTES FOR FETI
Five minutes before and five minutes after. Sound stimulation difference equals 24 ±2.3 per cent. From 1 to 127 days prenatal. Average 40 days prenatal.

RESULTS

In order to determine whether there was an increase in activity in response to the sound stimuli, two comparisons were made. The percentage of minutes during the control period in

which one or more movements occurred, active minutes, was compared with the percentage of active minutes immediately following stimulation. By immediately, we mean the first minute only, following stimulation.

Table 1 shows the average number of movements per minute during control periods, the average number of movements during the first minutes following stimulation and the changes in moves per minute. All these figures are shown in relationship to the number of weeks or months prenatal at which the records were taken. *Figure 1 shows graphically the* mean increase in the number of moves per minute after stimulation for the entire group. Table 2 duplicates the information of table 1 except that it deals with the percentage of active minutes instead of the number of movements per minute. *Figure 2* shows graphically the mean increase in the percentage of active minutes before and after stimulation for the entire group. Table 1 and table 2 show that during the last month prenatal there is almost one hundred per cent increase in both the number of movements per minute and the percentage of active minutes following stimulation. In the eighth month prenatal the response is less marked, but nevertheless, definite. The seventh month shows, in the number of movements per minute, an increase of 24 per cent after stimulation and, in the number of active minutes, an increase of 12 per cent. An examination of the seventh month by weeks reveals the fact that whereas, during *the ninth and tenth prenatal* weeks, there is evidence of a response to auditory stimulation, the figures for the eleventh and twelfth prenatal weeks show no response to stimulation. When a sufficient number of cases have been studied to determine more accurately the norm for the age of development of these responses, the comparison of the age and degree of response of a fetus to sound stimulation may serve as some index of the degree of development of its neuro-muscular systems. The cases we have studied indicate that there is considerable individual variation in the response of the fetus both as to its development and its reliability on successive days. *Although relatively little* data are available for tests before the seventh, that which we have shows occasional responses scattered throughout the sixth month.

Table 3 gives the number of movements per minute before stimulation *as compared with the first minute* following stimulation of each subject. Patient B, during 23 experiments, and patient E, during 50 experiments both show a slight decrease in movements in the minute following stimulation. Whether these negative cases are the result of differences in thickness of the structure overlying the fetal head or whether they are developmental differences which may be demonstrable at birth has not been determined.

SUMMARY

1. In a series of 214 experiments on seven women there was a reliable increase in the detectable fetal movements in the first minute following the application to the mother's abdomen of a sound stimulus of a frequency of 120 per second.

2. The response to sound stimulus is detectable about the beginning of the thirty-first week of intrauterine life.

3. The response increases in magnitude as the fetus nears term. The per cent of time during which the fetus is active by months is:

- During the last prenatal month, 49 per cent before and 86 per cent after.
- During the second month before birth, 51 per cent before and 81 per cent after.
- During the third month before birth, 51 per cent before and 37 per cent after.

CONCLUSIONS

The human fetus is capable of responding to a sound stimulus applied to the maternal abdomen, by increase in movement of the fetal muscles. The response becomes more marked as term approaches. We believe that the development of such a response may furnish some index of the development and maturity of the fetus.

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Variations with Age in Frequency Distributions of Degrees of Handedness

Mary M. Roos

INTRODUCTION

THERE seems to be no phase of the history of man which does not bear record of his dexterity. Indeed, it would seem that language, social and religious usages, and man's handicrafts throughout the whole period of his existence have been profoundly affected by his preference for the right hand.

The problem of determining probable causes of this preference for the right hand has long engaged the attention of thoughtful men. In fact, there is today a vast literature on the subject. One reading this literature must, however, be deeply impressed by the fact that few studies of statistical significance have been made. As an example of statistically significant studies, it may be noted that Woo and Pearson (6) have made careful statistical studies of the relation of handedness and eyedness using data of 7,000 observations made by Frances Galton.

Several investigators of handedness and its causes have noted that subjects have shown varying degrees of skill with the right or left hand and yet no one seems to have investigated the frequency distribution of this variation in skill. There has also been a great deal of argument regarding the merits of the various tests for handedness,—the writing test, the number marking test, the tapping test, the strength of grip test, etc.,—and yet no one knows just what each really tests and what frequency distribution should be expected from each one. Furthermore, it does not seem to have been recognized that the tests may really be tests for different things,—for instance, that the writing and number marking tests may be tests of how much skill the subjects have obtained in either hand as a result of environment and that the tapping test, for example, may not measure environmental effects to such a great extent.

It would seem that no great quantitative progress in the study of handedness can be expected until the unit of measurement has been standardized. In other words it is of primary importance to determine just what each test measures and how degrees of handedness are distributed in the normal population.

This paper presents a statistical analysis of data gathered to determine the extent of handedness and the frequencies of degrees of handedness in three typical cross-sections which are represented by kindergarten or pre-school children, sixth grade chil-

dren and adult college students in Washington, D. C., U. S. A. Thus, the groups contained children whose ages were approximately four to six years for the kindergarten group, and eleven to thirteen years for the sixth grade group. In the college group some subjects were 16 years of age and some above 20 years, but the vast majority were between the ages of seventeen and twenty. I wish to acknowledge my indebtedness to Miss Jessie La Salle of the Washington, D. C., public school system, who made possible the study of the kindergarten and sixth grade children, and also to Professor Fred A. Moss for his many valuable suggestions, and for his coöperation in the gathering of data, and to Professor Charles F. Roos for his helpful statistical advice.

TESTS OF HANDEDNESS

The 3 groups, kindergarten, sixth grade, and college students were given a tapping test for handedness. Each subject was brought before a telegraphic key and asked to tap it at his maximum rate for exactly sixty seconds as recorded by a stop-watch. Care was taken to make sure that the subject understood what was expected of him before the tapping began. Each subject was given a brief practice period with each hand and then allowed to tap. The number of taps was automatically recorded by an electric counter.

To make certain that the kindergarten children should not know that their handedness was being tested and perhaps definitely try to prove themselves right-handed in order to avoid a possible odium, they were told that the test was to see how fast they could tap with each hand. This explanation sufficed, and it is believed that there is no bias in these data. In the case of the sixth grade this precaution to avoid bias was not exercised. The sixth grade data were the first to be taken and were recorded before it was realized that subjects might attempt to prove themselves right-handed if they knew that their handedness was being tested. This tendency was particularly noticed in a later college group for which the observations were thrown out. One might expect more bias in the case of college students than in the case of sixth grade children. The latter would quite naturally be awed by the presence of a tester who carried credentials from the office of the Superintendent of Education and would, therefore, not be apt to do other than told. Analysis of the data indicates, furthermore, that if there is any bias in the sixth grade data, it is very slight. In obtaining the data for the college students that are recorded here, the subjects were told that the test was one of reaction time. Each subject was inspired to tap with a maximum effort in each hand in order to prove himself to have a high reaction time. Approximately three hundred subjects were tested in each group.

For a grip test, readings were taken with a squeeze dynamometer for both hands of 242 college students. Three readings were taken from each hand, with the hands being used alternately to obviate differences due to practice or fatigue. The average of the 3 readings for the right hand and the average of the 3 readings for the left hand are recorded in table 1B.

The technique of the number marking test involved the drawing of short vertical lines through numbers on a sheet of numbers as rapidly as possible. An initial practice period of 60 seconds was given each hand. This was followed by 2 thirty second marking periods given alternately to the right and left hands. The results of this investigation are given in table 1A.

In the case of the tapping test, a record of the reported handedness of individuals in the college group was made to compare with the tested handedness. The reported handedness was recorded after the tests for reaction time had been completed. Table 2 gives the results of this comparison of reported handedness with tested handedness. There is no need to explain this table other than to say that of the 205 subjects tested all except 3 who said that they were left-handed indicated left-handedness by

TABLE 1

Frequency distributions—College students

A. NUMBER MARKING TEST					B. STRENGTH OF GRIP TEST				
Class logarithms	Class intervals x	t_n	F_n	f_n	Class logarithms	Class intervals x	t_g	F_g	f_g
−.235	−0	−3.760	2	0	−.135	−6	−3.675	1	0
−.185	−8	−3.350	2	0	−.110	−5	−3.139	1	0
−.135	−7	−2.934	2	1	−.085	−4	−2.602	2	2
−.085	−6	−2.518	3	2	−.060	−3	−2.066	3	6
−.035	−5	−2.102	4	6	−.035	−2	−1.530	13	16
+.015	−4	−1.685	6	14	−.010	−1	−.993	36	31
+.065	−3	−1.269	15	25	+.015	0	0	44	51
.115	−2	−.853	31	40	+.040	1	.080	58	51
.165	−1	−.437	66	52	.065	2	.616	30	42
.215	0	0.000	75	57	.090	3	1.153	34	26
.265	1	.395	54	52	.115	4	1.689	8	12
.315	2	.811	46	41	.140	5	2.226	4	4
.365	3	1.228	17	27	.165	6	2.762	2	1
.415	4	1.612	10	16					
.465	5	2.060	4	7					
.490	6	2.476	2	3					
.540	7	2.892	2	1					
.590	8	3.308	1	0					
.640	9	3.725	1	0					
Totals			343	343				242	242

Number marking test:

Mean = .050 Class intervals = .240 + .0025 = .242

Standard deviation = 2.4033 Class intervals = .050 × 2.4033 = 1.2017

$\frac{N}{\sigma} = \frac{343}{2.4033} = 142.720$

Strength of grip test:

Mean = .851 Class intervals = .0275 + .0213 = .0488

Standard deviation = 1.864 Class intervals = .025 × 1.864 = .0464

$\frac{N}{\sigma} = \frac{242}{1.864} = 129.828$

the tapping test. These 3 were shown by the test to be ambidextrous. On the other hand a number of those who reported themselves to be right-handed tested left-handed by the tapping test. The reason for this apparent failure of the tapping test is that the tapping test presumably measures what may be called native handedness as opposed to acquired handedness.

TABLE 2

Reported handedness compared with tested handedness

College students

TAPPING TEST CLASS BY RATIO	REPORTED HANDEDNESS			
	R	A	L	T
.69	2	0	2	4
.73	3	0	1	4
.77	1	0	0	1
.81	2	0	2	4
.85	3	0	1	4
.89	8	0	4	12
.93	6	0	5	11
.97	11	1	1	13
1.01	29	1	3	33
1.05	41	1	0	42
1.09	20	1	0	21
1.13	31	0	0	31
1.17	26	0	0	26
1.21	8	0	0	8
1.25	25	0	0	25
1.29	0	0	0	0
1.33	5	0	0	5
1.37	1	0	0	1
1.41	7	0	0	7
1.45	4	0	0	4
Totals	242	4	19	265

R = righthanded; L = lefthanded; A = ambidextrous; and T = R + A + L.

INDICES OF HANDEDNESS

It is not enough to say that human beings are right or left-handed. For instance, suppose that subject A registers 125 taps with the left hand and 200 taps with the right hand. It may be concluded that subject A is right-handed, but this does not adequately describe his right-handedness, for subject B, who taps 190 with his left hand and 200 with his right hand, is also right-handed. It can hardly be said that subjects A and B possess the same degree of right-handedness.

The quantity, R/L, where R represents the number of taps made by the right hand, or the right count, and L is the number of taps made by the left hand in the same period of time, or the left count, may be taken as a measure of the degree of handedness. Hereafter, this ratio, R/L, will be called a *handedness ratio*. It gives a quantitative measure of degree of handedness. It describes always the relationship between the two hands, not the reaction time of either hand, nor the number of marks made by either hand. Thus, it is simply a number, that is, it does not have dimension. It serves very well to eliminate the personal elements that naturally vary with individuals.

If subject C taps 250 with the left hand and 400 with the right hand, then, according to the handedness ratio, subject C has the same degree of right-handedness as subject A who taps 125 and 200, respectively, with the left and right hand, for, $R/L = 400/250 = 200/125 = 1.60$. If subject D taps 300 and 200, respectively, with his left and right hands, then his degree of left-handedness is $R/L = 200/300 = .67$. Theoretically, one represents ambidexterity, but due to the nature of the tests used and the

statistical elements involved, it is probably better to say that ambidexterity is defined by an interval having one as its mid-point, for example, by the interval .95 to 1.05. For the purposes of this study it is, however, not necessary to define what is meant by ambidexterity.

The ratio, R/L, has one obvious disadvantage as a measure of degree of handedness. By definition the range of right-handedness is from one to infinity (paralysis of the left-hand), whereas the range of left-handedness is from zero (paralysis of the right hand) to one. In other words the ratio is an asymmetrical index of degree of handedness. As a symmetrical index of handedness the logarithm of R/L naturally suggests itself. For this index left-handedness is distributed over the range minus infinity to zero, and right-handedness over the range zero to plus infinity. There is, therefore, no bias either to the right or to the left, and, furthermore, the logarithm is a function that takes into account relative differences which seems to be what is desired. It may, therefore, be regarded as an ideal index of handedness and is used in this paper.

FREQUENCY DISTRIBUTIONS OF HANDEDNESS RATIOS

Table 3 gives the observed distributions of handedness ratios determined by the tapping test for the kindergarten, sixth grade and college groups.

The percentages which tested left-handed in the kindergarten, sixth grade and college groups are respectively 18.6, 10.2 and 17.2. The differences, which can not be regarded as significant, indicate that there may be little disagreement in the incidence of right and left-handedness in the three widely separated age groups studied, provided the tapping test is used. It will be shown presently that this is probably the case. The percentages given by the present study do not agree with the 4.62 per cent of boys and the 2.62 per cent of girls who were left-handed that has been reported by Wilson and Dolan (5) in their study of 2328 junior high school students. They do agree, however, with the twenty per cent of left-handedness and ambidexterity reported in a study (1) of the natives of Murray Island, and the 18.3 per cent of left-handedness obtained by the author (4) in a study of 480 infants. On the other hand, Wilson and Dolan used a writing test and their percentages are in approximate agreement with the percentages obtained in that part of the present study in which a number marking test was given to college students. Furthermore, the strength of grip test was given to the Murray Islanders and as will appear from the present study, the mean and standard deviations for the grip test and tapping test as applied to the same group of college students are very nearly alike. Further analysis seems to indicate that the tapping test and strength of grip test probably measure native handedness as distinct from acquired or learned handedness.

The 290 kindergarten children range in degrees of handedness from $-.1600$ to $+.2150$ (logarithmic indices) with the arithmetic mean at $.0484 \pm .0022$, where .0022 is the probable error. For this group, the standard deviation is $.0500 \pm .0010$. Both the mean and

the standard deviation are very large compared with their probable errors, and hence are highly significant. The 398 college students range in degrees of handedness from −.1850 to +.2400 the mean being .0415 ±

TABLE 3

Frequency distributions—tapping test

CLASS INTERVAL	MID-POINT X	KINDERGARTEN			SIXTH GRADE			COLLEGE				COMBINED		
		t_k	F_k	f_k	t_s	F_s	f_s	t_c	F_c	f_c	ϕ_c	t_g	F_g	f_g
−.185	−.1725	−3.9446	0	0	−3.7103	0	0	−3.7676	2	1	2	−3.7907	2	0
−.160	−.1475	−3.4982	1	0	−3.2964	2	1	−3.3275	1	1	2	−3.3581	4	1
−.135	−.1225	−3.0518	1	1	−2.8825	1	1	−2.8873	2	2	4	−2.9256	4	2
−.110	−.0975	−2.6054	2	2	−2.4680	3	2	−2.4472	6	3	4	−2.4931	11	8
−.085	−.0725	−2.1580	4	5	−2.0546	0	6	−2.0070	3	9	5	−2.0606	13	20
−.060	−.0475	−1.7125	11	12	−1.6407	12	12	−1.5669	10	20	11	−1.6280	42	45
−.035	−.0225	−1.2661	15	24	−1.2208	15	22	−1.1268	21	37	27	−1.1955	51	83
−.010	.0025	−.8196	48	38	−.8129	35	34	−.6866	52	53	54	−.7630	135	128
.015	.0275	−.3732	54	49	−.3990	39	44	−.2465	84	68	84	−.3304	177	161
.040	.0525	.0732	50	52	.0149	61	48	.1937	87	69	85	.1021	198	169
.065	.0775	.5196	38	46	.4288	35	44	.6338	59	57	60	.5346	132	148
.090	.1025	.9661	36	33	.8427	43	34	1.0739	34	39	32	.9671	118	106
.115	.1275	1.4125	23	19	1.2566	23	22	1.5141	11	22	12	1.3997	54	64
.140	.1525	1.8589	8	9	1.6705	10	12	1.9542	8	10	6	1.8322	29	32
.165	.1775	2.3054	4	4	2.0844	3	6	2.3944	6	4	5	2.2647	13	13
.190	.2025	2.7518	1	1	2.4983	3	2	2.8345	1	1	3	2.6972	5	4
.215	.2275	3.1982	0	0	2.9123	0	1	3.2746	2	1	2	3.1298	2	1
			296	296		291	291		398	398	398		985	985

Statistics of frequency distributions

STUDY	OBSERVATIONS	MEAN	PROBABLE ERROR OF MEAN	σ	PROBABLE ERROR OF σ	N/σ
Kindergarten	296	.0484	.0022	.0560	.0016	132
Sixth grade	291	.0516	.0024	.0604	.0017	120
College	398	.0415	.0010	.0568	.0014	175
Composite	985	.0466	.0012	.0578	.0008	426

Here, F_k, F_s, F_c, and F_g are observed frequencies; subscripts k, s, c, and g, stand for kindergarten, sixth-grade, college, and combined, respectively; t_i is equal to (X − Mean of i^{th} Distribution)/σ_i where i = k, s, c, and g; $f_i = N_i\phi(t_i)/\sigma_i$; $\phi_c = f_c + 353\phi^{(4)}(t_c)/4!$; N_i is the total number of observations in the i^{th} set; σ_i is the standard deviation of this set in class intervals; and $\phi_i(t_i)$ is the normal probability function and $\phi^{(4)}(t_c)$ is the fourth derivative of $\phi(t_c)$.

.0019 and the standard deviation .0568 ± .0014. The 291 sixth graders range in degrees of handedness from −.1600 to +.2150 the mean being .0516 ± .0024 and the standard deviation .0604 ± .0017.

It is readily seen that the range of handedness is just about the same

for all 3 groups. Also, the means, .0484 ± .0022, .0516 ± .0024, and .0415 ± .0019, are very nearly alike. Similarly, the standard deviations of .0560 ± .0016 for the kindergarten group, .0694 ± .0017 for the sixth grade group and .5680 ± .0014 for the college group are not greatly different.

It is interesting, therefore, to compare these statistics, *e.g.*, the mean and standard deviation of each group, with the mean and standard deviation of a composite group of 985 subjects consisting of the 296 in the kindergarten group, the 291 in the sixth grade group, and the 398 in the college group to determine the probability that the mean or standard deviation of any random sample taken from the composite group, here assumed to give the best estimates of the mean and standard deviation for the universe, will exhibit the variations in the three samples presented here. The mean for the composite group may be calculated directly as .0466 ± .0012 and the standard deviation as .0578 ± .0080.

To detect significant differences in the samples, the difference between the composite mean and the mean for each sample may be compared with their probable errors. It is well known that the probable error of the difference of two quantities is the square root of the sum of the squares of the probable errors of the quantities. See, for instance, Jones, (3). A short calculation shows that the difference of none of the means is greater than 3 times the probable error of the corresponding difference. Similarly, it is easy to show that the maximum difference of each standard deviation is less than the corresponding probable error so that again differences are not significant.

Thus, consideration of only the first 2 moments, leads to the conclusion that all 3 samples, kindergarten, sixth grade and college probably came from the same universe, that is, that living in a right-handed world probably has no influence on the distribution of degrees of handedness as measured by the tapping test. An important problem, therefore, is to determine whether or not the third and fourth moments are significant and if they are significant, whether or not differences in these moments can be attributed to sampling errors.

An application of the Pearsonian Chi Square Test of Goodness of Fit (2) to the data for the kindergarten group shows that despite the discrepancy pointed out in the $-.035$, $-.010$, .065 class intervals, the normal curve gives a very good fit. On the basis of this test one would naturally be led to conclude that the distribution of Log R/L for the kindergarten group is normal. In view of the results of the sixth grade and college groups to be presented shortly, it is, however, more likely that a slight shift to the right occurred in the left-handed groups $-.035$ and -0.10.

When calculations for the sixth grade are made as they were for the kindergarten group, it is found that the normal distribution given by column f_t in table 3 seems to agree very well with the observed frequency F except for the class intervals $-.035$ and .065 where disagreement was found for the kindergarten group.

On the other hand, for the college

group, the normal distribution given by column f_c does not seem to afford a good fit to the observed frequencies. Indeed, a short calculation indicates that there is about one chance out of twenty that a sample drawn from a normal universe would differ from the normal as much as does this sample. A comparison of the difference between the observed frequencies and the calculated normal frequencies shows that the fit will be materially improved by adding a kurtosis function to the normal curve. In fact, the frequency distribution

$$f_c = (N/\sigma)\varphi(t) + (K_4/4!)\varphi^{(4)}(t)$$

where $K_4 = 352.8$ and N and σ have the values given in table 3, adequately represents the distribution for handedness of college students, the chances being a little better than even that the sample came from the distribution given by the normal probability function $\varphi(t)$ and its fourth derivative.

It is not unreasonable to suppose that the distribution of the handedness index would change from the kindergarten age to the college age, as indicated here, that is, that in the college group there should be a greater concentration than normal around the mean at the expense of adjacent regions.

The fact that the mean for all groups is definitely on the right-handed side would be sufficient to explain the world-wide preference for the right hand. If the mean be taken to indicate the usual preference given to the right hand in a right-handed world, then it might be expected that continued application of this conventional preference by individuals whose handedness indices were several units on each side of the mean would tend to change their indices into ones nearer to the mean. Thus, there would be a concentration about the mean, as indicated by the college group.

In the case of the kindergarten and sixth grade groups it may be said that this tendency to group about the mean has not had time to manifest itself. It will be recalled, however, that in both the kindergarten and sixth grade groups shiftings in the groups near the means toward the means were slightly indicated.

In view of the results presented here, it is indicated that the handedness index of a group of infants, as measured by the tapping test or some other test of what may be called native handedness, would be distributed normally, that is, that Log R/L would be distributed normally.

This study suggests the important hypothesis that there is no one assignable cause of degrees of right or left-handedness, but rather that there are a great many equally important causes. In view of the great number of theorizings that have been published on the causes of right and left-handedness, this conclusion is an important one (4).

FREQUENCY FUNCTIONS FOR THE STRENGTH OF GRIP TEST

The results of a strength of grip test administered to 242 college students are explained in section two and summarized in table 1B. The mean and standard deviation do not differ greatly from the mean and standard deviations of frequency distributions for the tapping test, and, furthermore, Log R/L is distributed normally.

The frequency distribution for the grip test, however, does not show the concentration about the mean shown in the case of college students given the tapping test. This may mean that the former is a better test of native handedness than the latter when applied to adults. It might be expected that such predominantly right-handed activities as writing would be more apt to modify the frequency distribution of the tapping ratio or tapping index than they would the strength of grip. In other words, it may be possible that throughout life the left hand is used for gripping purposes in approximate accordance with the infant distribution of the handedness index, but a great deal more experimentation is necessary to prove or disprove this hypothesis.

FREQUENCY DISTRIBUTION FOR THE *NUMBER MARKING TEST*

Table 1A summarizes the observations in connection with a number marking test administered to 345 college students as explained in section 2. Here the handedness index Log R/L is almost certainly not distributed normally. Nor is the distribution for the number marking test simply modified by skewness and kurtosis. In a general sort of way the distribution reminds one of the normal curve, but it cannot be considered to be normal. In particular, there seems to be marked deficiency in the classes on each side of the mean, and marked excesses in both right and left extremes. It may be verified readily that in order to obtain a satisfactory fit, it is necessary to include terms to $\varphi^{(7)}(t)$. There is, however, no reason for expecting the distribution for the number marking test to be normal since learning has definitely played a part in modifying an indicated normal curve at birth.

CONCLUSIONS

On the basis of the results presented here, it would seem reasonable to conclude that:

1. It is indicated that the logarithmic handedness index of a group of infants as measured by the tapping test or some other test of what may be called native handedness, is distributed normally, that is, that Log R/L is distributed normally.

2. Handedness is a trait which is manifested in varying degrees in different individuals and the age of the subjects does not materially affect the degree of its manifestation when it is measured by a tapping test or a strength of grip test.

3. About 81 per cent of people show greater native ability with their right hand than with their left as indicated by the tapping test, whereas approximately 96 per cent learn to use their right hand preferentially as indicated by the number marking test. In other words, 75 per cent of those who have greater native ability in their left hand as indicated by reaction time (tapping test) develop preferential use of the right hand presumably due to the effect of living in a right-handed world.

4. The theory that handedness is an inherited quality finds support in this investigation, for, among the samples, the kindergarten, the sixth grade, and the college groups, the statistics of the mean, the mode, and the standard

deviation, do not vary more than is expected by chance. This thesis finds further support in the author's study on an infant group.

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An Experiment with Posture Work in a Nursery School. A Preliminary Report

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INTRODUCTORY STATEMENT

GOOD posture is undoubtedly an enviable asset. Development of muscle groups upon which good posture depends cannot begin too early. Anything which motivates children in the right direction here will undoubtedly be of advantage to the continuation of their healthful living.

Desirable as is a posture program in the nursery school where children of from two years to nearly five come together, it has not often been a feasible endeavour to carry out. In the first place it is not often feasible to have elaborate posture apparatus in a nursery school. In the second place, it is not often feasible to have in daily attendance a trained expert in posture who can give to the children both passive and active corrective and developmental exercises. Hence to evolve a posture program which could be simply carried on by nursery school teachers appeared highly desirable. In consequence a first question arose:

What can the teacher who has had little or no posture training do under the occasional direction of a consulting *orthopedist and without elaborate* posture equipment? Can she in the natural environment of the nursery school help the children to correct development of those muscle groups upon which good posture depends?

The first solution that occurs is to arrange exercise periods and have the nursery school teacher learn how to give certain simple exercises to the children. But on further consideration such a solution seems both premature and lacking in thoughtfulness. The nursery school child is in a developmental period of growth where attention to tasks imposed by others is difficult. He is exceedingly active, but his activities have short duration span and shift quickly.

Activities imposed on him in a set form by others not only fail to appeal after their first novelty has worn off, but *often call forth outright negativism.* The child during these early years is called on to learn so many fundamental habits at the will of others, that if many additional items are asked of him, he begins to balk at everything. Psychologists have pointed out that demands are best limited to routines of eating, sleeping, elimination, and to safeguarding from danger for children between two and five. They tell us that the negativism which children evidence at this period is a necessary phase in the develop-

ment of independence, and just for this reason advise rigid curtailment of as many imposed tasks as is possible lest the negativism have so much to feed on that instead of independence, rebellion results. Hence posture exercises which are set in form by the adult, even though sugar-coated into "games" run the danger of either calling forth negativism in direct response to them, or of intensifying the general negativism in the child at other times during his day, because of their contribution to an already heavy load of things being imposed from without onto an organism seeking for the first time to feel itself independent.

When we stop to think we realize how vital it is for a normal amount of independence to grow. We realize that in whatever guidance we do, we must help such growth rather than run the danger of shaping the child into a dependent, submissive person who turns out lacking in stamina and forcefulness. A second danger in too many imposed tasks confronts us here. As had been said too many imposed tasks may intensify the child's negativism. With some children this is true. With others just the opposite may occur. Instead of becoming negative the child may become submissive to adults, seek to comply to gain favor, and finally come to need others to initiate, inaugurate and to sanction activities. Thus with a certain rather sensitive type of child, too many imposed tasks in the preschool period can do this instead of its opposite. So again, we are faced with the problem of the necessity for guarding against set, imposed exercises in our posture program.

On the other hand, activities that are spontaneous, that have meaning to the child, that are done for their own sake because of the fun of doing them—activities which are not too much patterned by the adults around, but instead are activities which the child himself thinks of doing—such activities are repeated again and again. They become a part of the child's vital and vigorous play, they become functional in his living. Such, then, are the sort of activities which we must try to find ways of incorporating into a posture program for the nursery school.

PURPOSE

An experiment was undertaken to work out in a nursery school a posture program which would be a feasible one for the regular nursery school teacher to carry on under the occasional direction of a consulting orthopedist; and which would, moreover, be adapted to the age, interests and capacities of children between two and five.

It was agreed that to do this the program would need to steer away from the didactic and from set exercises. It would need to fit in with the natural environment and play activities of the children. It would need to lend itself to free and spontaneous use by the children. In short it would need to be a functional program in which healthful postural habits might grow in the natural work and play of the day.

Procedure

The study was carried on from March 3, 1935 to June 3, 1935, in the Broadoaks Nursery School of Whittier College.

1. Special needs of the children in the nursery school where the study was undertaken were determined through measurement, examination and photographs by the orthopedist.

2. The general postural needs of children from two to five were outlined by the orthopedist. It was agreed to work out the program under consideration, with special emphasis placed on development of feet and lower spine. The posture objectives included the following:

- A. Feet
  1. To lessen inherited contractures and to have feet accomplish at least a 90 degree dorsal flexion.
  2. To develop plantar-flexor muscles.
  3. *To make it habitual to walk with* feet somewhat inverted, i.e. with feet pointing straight ahead.
- B. Pelvis
  1. To incline pelvis backward—to create a roll of pelvis backward in order to prevent or eliminate lumbar lordosis.
  2. To develop the buttocks or gluteal muscle group.
  3. To stretch the hamstring muscle group.
- C. Trunk
  1. To develop abdominal muscles.
  2. To educate thoracic-spinal muscles by contraction and shortening.

3. The nursery school environment at the Broadoaks School of Education, Whittier College, was gone over by the orthopedist with the view in mind to note (*a*) those pieces of equipment and (*b*) those activities already going on as part of the nursery school program, which if utilized, or accented, or encouraged, might help the children's posture.

4. The addition of further simple and inexpensive pieces of equipment, or slight changes in equipment already in the environment was considered, and carried out.

5. The addition of greater opportunities for the sort of play and for the use of the equipment which would develop good postural habits was gone into and utilized.

6. Means of accenting the use of equipment and of encouraging spontaneous activities in order to carry out the posture objectives were tried out with the children.

Subjects

Thirty-six children enrolled during the spring semester of 1935 in the two nursery school groups at the Broadoaks School, Whittier College, were the subjects of this study. No special posture work had been given to these children previously. The distribution of subjects according to age levels is given in table 1. The entire group used in this study ranged in age from twenty-one months to fifty-seven months at the time the study was begun.

TABLE 1

Distribution of cases by age and sex

AGE RANGE TO NEAREST MONTH	NUMBER OF		
	Boys	Girls	All
21–35	5	5	10
36–47	5	12	17
48–57	6	3	9
Total...	16	20	36

Program evolved:

1. Measurements and examination of each child were made by the orthopedist.

2. Equipment was arranged and opportunities made for posture activities to go on quite naturally during the children's daily play, as follows:

A. Activities for developing the feet.
   1. To help lessen inherited contractures and to have feet accomplish a greater degree of dorsal flexion, inclined boards were arranged having one end resting on the ground, and the other end on boxes. These were already popular in the nursery school yard. By seeing that the boxes were from 25 to 30 inches high, the angle could become acute enough to automatically make for foot flexion stretching heel cords, as well as hamstrings, as the children went up.

      A song about climbing up the board sung by an observant teacher when she noticed children nearby served to draw their attention to the boards and so encouraged the use of them daily. The children, however, were never lined up and formally put through this or any of the following activities. The stage was set so that the activities could take place, and the children were encouraged individually to enter into them, but never were they formed into groups that went through drills or didactic exercises.
   2. In order to help make it habitual to walk with the feet somewhat inverted, (i.e. pointing straight ahead) the lines on the tennis court which was used as a part of the regular play-yard, served as admirable equipment, (as could any straight line drawn with chalk, or other material).

      Walking on these lines proved to be greatly enjoyed and automatically brought the desirable inverted position of the foot.

      A teacher singing a song about walking on the line, quite incidentally now and again throughout the day, invariably attracted three or four children at a time, each one wanting "a turn" to have the song sung to him while walking.
   3. Plantar-flexion appeared to take place somewhat, even though shoes were on, as the children climbed on the round rungs of the jungle gym.

B. Activities for the pelvis.
   1. As children play, they often "squat" or kneel. It was observed that the squatting, which they do with heels as well as the front part of the feet on the ground, throws the pelvis into good position. Hence when children played building blocks, digging in the ground or sand, and so on, they were encouraged individually to "sit on their feet" instead of their knees.
   2. To develop the large buttock muscles (or gluteals).
      a. A little low fence onto which the child could lean forward and support himself was added to the nursery school equipment. Behind it a ball was suspended from the horizontal bar, so that the child, leaning forward supporting himself on the fence, could kick out backward, bringing the gluteal group into play.

         The teacher would sing about kicking "your foot way back at the ball," helping to attract attention to this type of activity.
   3. To stretch hamstrings or develop quadriceps.
      a. Talking or singing about dogs invariably would bring dramatic play in wake. Children would go down on hands and knees, barking and crawling about.

         It was a simple thing to ask then, if dogs walked on their knees or their feet. A picture was shown. "Oh," said a child, "They walk on their feet," and down he went, not on knees this time, but on hands and feet. Further encouragement from time to time to keep knees straighter was given, and although perfectly straight knees were not achieved

frequently, yet they continued to move in the right direction, for extension.

b. Often children pick up things from the ground. "Can you pick them up while your legs stay straight?" (because of postural objectives) came to be a challenge, so much so that one day a child at music time around the piano, demanded to play picking up rocks with straight legs. Thus both as picking up happened actually in their play and as they dramatized it, the children were having opportunities for good extension of hamstrings.

c. The muscles at the front of the thigh (the quadriceps) came in automatically for much exercise as the children used tricycles, or jumped on the jumping boards, climbed up and jumped down off the low platforms and boxes or climbed on the jungle gym.

C. *To develop muscles of the trunk.*

1. To develop abdominals.

One day a lady bug was seen on its back, kicking its legs. The children were greatly interested. One child got down onto the floor and dramatized the bug's kicking. "I'm the bug kicking," he said.

The teacher immediately fitted a song to the activity. A rug was laid on the ground. Several became bugs, kicking in the air. Thereafter, whenever the song about the bug was sung, either outside under the trees or inside at "music time," children would navigate to the singer, and begin this activity.

The teacher encouraged that legs stay high enough to be at right angles to the body so that the lower back automatically remained touching the floor.

b. The barrel in the yard was dramatized also by several children. With just a few suggestions, this turned into rolling from side to side, with knees clasped in rhythm to a song sung to those children who at the moment felt like entering in.

2. Toward the end of the experiment a boat was introduced, on which the oars were fastened to the sides with ordinary door springs, so that there was resistance met both in pulling back and pushing forward, excellent for the shoulder and trunk muscles.

3. As the children made use of a low board swing, it was found that use of all trunk muscles took place, especially the abdominals.

4. Climbing on the jungle gym appeared good for all trunk muscles—as well as for the pelvic groups and for development of feet.

All through, hanging on the bar, proved of interest, and was considered good for general stretching and relaxation.

Again, it must be stressed that in none of the above was there lining up of the children and putting them through the paces. This will be clearly seen as examples are read in the concluding section of this paper, as outcomes are described.

Means of accenting the use of equipment and of encouraging spontaneous activities in order to carry out the posture objectives, were found effective as follows:

1. Songs to attract the children to pieces of apparatus by directing their attention to them.
2. Introducing into music period, songs *for dramatization* which automatically —or with very limited suggestion brought forth developmental use of muscle groups.
3. Having apparatus interestingly arranged, and differently arranged from time to time to attract attention.
4. Shifting or moving apparatus while children were around to focus interest and hence call forth use.

Not being a set program, part of the carrying out involved a means of checking each day those children who participated at one time or another during the morning in the activities for posture development. A check list was therefore posted for this purpose. Its checking each day assured the teacher's being able to determine which children would be needing more stimulation and encouragement to enter in.

OUTCOMES FOR THE FIRST FOUR MONTHS OF THE EXPERIMENT

1. As will be recalled, the first aim of the experiment was to set up, or emphasize activities which would bring into play correctly certain muscle groups important for posture development in a way that could be carried on by nursery school teachers, with no particular posture training, under the occasional direction of an orthopedist.

Whether or not the work was fitting in with this aim has been carefully watched. The director of the nursery school, two full-time teachers and nine student-teachers have been carrying on the work with occasional direction from the orthopedist. None of these teachers had any training in such work, yet none of them found it difficult to carry it on in a way that seemed correct as checked by the orthopedist.

This then, would seem to indicate that such a program is feasible for the average teacher under occasional expert direction.

2. A second aim was to have the posture program adapted to the age interests and capacities of children between two and five.

In regard to a fitting in with capacities first, the fact that all the 36 children enrolled in the nursery school were able to enter into the activities independently without any adult assistance and without any apparent feeling of strain or insecurity, indicated that there was nothing too difficult or beyond their capacities in the program.

As to whether or not the program fitted in with their interests, the greatest surprise came here. Tremendous interest was shown. A teacher would sing a song, for instance, about "Walking on the line" when she caught sight of a single child in the vicinity of one of the lines on the tennis court which served as a part of the nursery school playground. In response, not only would the child already near the line enter in, but others in addition would come running to join the line walkers. Or if the teacher would sing about one child kicking backward (for buttock group development), or about one walking up the board (heel cord and ham-string stretch), along would come others demanding "a turn too." Or the mere sight of rugs being spread on the ground, would bring half a dozen or more children running "to kick like bugs" (abdominals) while still others would demand turns here also. And so on, with each single one of the activities within this program.

According to the careful check list kept, out of the 36 children, 34 entered in *every single* day voluntarily. Two children only needed direct suggestion or a bit of urging. From this it can be seen that interest all through was high.

Examples of activities, jotted down as the incidents were observed, during

the last two weeks of the semester follow to illustrate the sort of responses the children made to indicate the interest they were taking in activities for posture development.

5-24-35: Marion (3/10)[1] is walking on the tennis court carrying her doll. The teacher, seeing that she is near the line and not engaged in any purposeful activity, starts to sing, "let us walk on the line, etc." Marion smiles, and starts line-walking. Hearing the song, Jock (4/10), Peggy (4/6), Prenty (4/0) and Kingsley (3/11) come running. They start to walk lines. Kingsley beams, "I'm *doing it too*." This goes on for about five minutes.

5-29-35: Marion notices that the boards of the wooden floor inside the house "make lines." She starts to walk along them, becomes engrossed in so doing. Smiles at another child, "I'm walking on the line in here."

5-29-35: Drucilla (3/6) found that she could walk along a six-inch board in the yard. She called to Roberta (3/0) that she was walking on a new line. Roberta joined her.

Notice that in the three instances cited above, the teacher suggested the activity in the first only (and then merely by singing a song), while in the other two instances the children themselves initiated and carried on.

Note too, that in the second and third instances the children adapted other equipment (not the lines on the court which the teacher had suggested), thus truly incorporating into their living the exercising of these particular muscle groups.

[1] (3/10) indicates the child's age, *e.g.* reads as 3 years, ten months, (4/0) as 4 years, zero months, etc.

5-23-35: Jackie (2/0) was near the apparatus for "kicking back at the ball." The teacher nearby started to sing, "Jackie is kicking way back at the ball, etc." Jackie at this leans over the fence and begins kicking back. Several other children come running for turns when Jackie is through.

5-24-35: Theanne (2/6) and Beverly (3/0) are running about together. Theanne catches sight of the apparatus for kicking back. She runs to it. "Let's do the funny trick," she says. She and Beverly then take turns doing it, each having about three turns at it.

5-30-35: George (4/1) and Linda (4/0) have climbed high up on the jungle gym. George suggests that they do a "funny trick" up there. They bend over one of the rungs, and kick back, repeating in their own inventive way, the movement done over the fence for the buttock group.

5-21-35: Kim (23 months) and Nancy R (2/6) and Nancy Y (2/6) take turns walking "Up the board" as the teacher plays on a little wooden flute, the tune that by now has become familiar as singing about going "up, up, up, up the board." An hour later, Nancy comes by herself, takes a running start, and laughing the while, runs up the board. She repeats this five times in succession.

5-22-35: A group of six are gathered around the piano. The teacher sings a song about "Bow wow Doggie walks around." Down onto the floor go all six children, on hands and feet, dramatizing the dog's walking, and incidently stretching hamstrings.

5-23-35: A rug has been spread outside on the ground under an olive tree's shade. The teacher sings about "Kick your heels in the air, like a great big bug," Marjorie (3/0) nearby hears the song. She comes over with, "I be a bug, only a

> little bug—a little red lady bug, I kick like he do when he on his back." Soon Barbara (3/3), Drucilla (3/6) and Janet 3/0) join. Later Marjorie returns, after the teacher is no longer there. She laughs, "I kick again." Roberta hears, and silently comes and lies down beside her, Jackie follows, and Theanne. There are the four of them, kicking like bugs, without ever having had suggestion to do so at the moment from any adult.

The above instances could be multiplied many times over, but it is felt that those cited are sufficient to show the interest and the eagerness and delight evidenced by the children in carrying on posture activities in an informal, nondidactic way.

CONCLUDING STATEMENT

An experiment was undertaken to incorporate a posture program freely into the daily activities of a nursery school, without set forms or times for the work. Equipment already in the nursery school was utilized and a few very inexpensive and simple additions or changes were made. Activities already current in the nursery school were utilized or encouraged in slightly modified form so as to fit in with postural needs. Development of specific muscle groups were aimed at throughout.

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Children's Feeding Problems in Relation To the Food Aversions in the Family

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Problem

ALTHOUGH the fundamental importance of psychological factors in feeding problems is quite generally emphasized in the literature, a rather careful search has failed to reveal any studies presenting data on possible causative psychological factors. Most of the psychological causes to which feeding problems are attributed are inferred from successful remedial training measures. Practically no quantitative data seem to be available on the problem in the home situation or on the influence of the food habits and attitudes of others in the household on the feeding habits of the child.

The present study was undertaken to investigate the food preferences and aversions of a group of young children, and to determine their relationships to food aversions among members of their families. In an attempt to throw light on some of the psychological factors underlying children's feeding problems attention has been devoted to: 1) the kinds of food offered to a group of feeding problem cases and to a similar group of normal eaters; 2) the kinds of food most frequently liked, disliked and refused by each group and the frequencies of these attitudes in each group; 3) the relation between age and attitude toward food; 4) the frequency of identical child and family food dislikes; and 5) frequencies of identical child-parent and of identical child-sibling food aversions.

Subjects

The subjects were 48 children between the ages of two years no months and seven years six months. The mean age of the group was 52.8 months. All of the children were either enrolled in the nursery school at the University of Georgia at the time of the study, or had previously attended the nursery school, or were the siblings of present or former members of the nursery school group. The subjects represent a highly selected group, coming almost entirely from professional and upper-class business homes. The 48 children came from 34 different families, there being 3 from one family and nine pairs of siblings. Twenty-one were boys and 27 were girls.

Fourteen of these children constituted a "feeding problem group," either because they were so classified by their mothers, or because of the prominence of feeding problems in

the histories of the cases as known to the nursery school. This is not an unduly high proportion of the total group to present feeding problems at these ages as judged by the reports of Maclay (3), who found 40 per cent, and Aldrich (1) who found 16 per cent of similar groups presenting such problems. In the feeding problem group there were 6 boys and 8 girls who averaged 58.6 months of age. The remaining 34 cases, 15 boys and 19 girls, averaging 50.4 months of age constituted the non-feeding problem group.

Method

The data for this study were secured by interviewing the mothers to determine whether the children liked, were indifferent to, disliked but ate, refused, or were not offered each of 72 foods. The mothers were also asked with regard to each food whether any members of the immediate household disliked or refused it. Excellent co-operation was secured from all informants.

The 72 foods considered represented an arbitrary sampling of foods commonly served in the locality, and necessarily included some items peculiar to the Southern diet. The major groups of foods with the number of items in each group were:—breads 5, cereals 6, desserts (exclusive of fruits) 7, eggs 5, fruits 14, meats (including fish) 7, dairy products (exclusive of eggs) 5, and vegetables (including rice and macaroni served as vegetables) 23. Meats were not listed according to different methods of preparation, and only one entry was made for fish. Eggs, however, were listed according to five methods of preparation, and some of the commoner fruits were listed both raw and cooked. While this may have tended to weight certain foods too heavily, and others may have received inadequate weight, it does not affect comparisons of the two groups of subjects.

RESULTS

A. *Feeding practices.* Of the 72 foods listed, on the average 85 per cent were offered to the total group, 84 per cent to the non-feeding problem group and 88 per cent to the feeding problem group. The tendency for the feeding problem group to be offered a slightly greater variety of foods than the non-problem group appears in the cereal, and dessert categories and was especially marked in the case of the dairy foods. Wide individual variations were found in the feeding practices, some children being offered all, and some only 40 per cent of the foods listed. As would be expected, there was a noticeable tendency for the younger children to be offered less variety than the older children, the rank order correlations between age and percentage of listed foods offered being .63 for the entire group, .66 for the non-feeding problem group, and .57 for the feeding problem group. This appears to be due chiefly to the tendency to omit meats and raw fruits from the diets of the younger children.

A qualitative consideration of the feeding practices as indicated by the kinds of foods offered to markedly different percentages of the feeding problem and non-feeding problem groups seems to indicate a tendency to allow the problem group more

carbohydrates, particularly biscuits, white bread, grits, macaroni, cake, candy and pastry as well as more meats, especially lamb and pork. Parallel with this may be noted the less frequent offering of several fruits generally considered to be more laxative, but the frequent use of bran, probably as a corrective. Striking contrasts which appear between the two groups regarding chocolate-milk and buttermilk are possibly indicative of efforts on the part of the mothers to tempt the children in the problem group to drink milk in some other form when difficulties were encountered with plain milk. It is also possible that the children who have known chocolate-milk are less satisfied by ordinary milk.

B. *Attitudes toward foods.* For each child the numbers of items which he liked, was indifferent to, disliked or refused were determined. The number of liked items as reported by the mothers ranged from 9 to 68 out of a possible 72 with a mean of 47.7. (See table 1.) The number of indifferents for individual children ranged from 0 to 61 (mean 8.5) with only the one extreme case above 10. Dislikes and refusals were relatively infrequent for all children. The number of dislikes ranged from 0 to 9 with a mean of 2.2 and the refusals from 0 to 20 with a mean of 2.6.

TABLE 1
Mean number of items in each attitude category

	NON-PROBLEM GROUP	PROBLEM GROUP	ALL
Like	50.2	38.8	47.7
Indifferent	6.7	12.0	8.5
Dislike	1.6	3.5	2.2
Refuse	1.7	5.0	2.6
Not offered	12.0	9.0	11.0

The first two columns of tables 1 and 2 indicate sharp contrasts between the two groups of children in all four of the attitude categories. The non-problem group liked 83 per cent while the problem group liked only 66 per cent of the offered foods. The problem group was indifferent to 20 per cent of the offered foods, this being nearly twice as great a proportion of indifference as among the non-problem cases. The same tendency is to be noted among the dislikes and refusals, there being twice as many dislikes, and nearly three times as many refusals on the average in the problem group as in the non-problem group.

TABLE 2
Percentage of offered items in each attitude category

	NON-PROBLEM GROUP	PROBLEM GROUP	ALL
Like	83	66	78
Indifferent	11	20	14
Dislike	3	6	4
Refuse	3	8	4

Table 1 indicates that there is practically a one-to-one relationship between the number of items disliked but eaten and the number of refusals in the non-problem group, while in the feeding problem group there were almost half again as many items refused as were eaten although they were disliked. Identification of individual cases presenting marked excesses of refusals over dislikes revealed cases

in which there was poor discipline in the home and where the child ruled rather than the parent in a variety of situations. This manifestation in the feeding situation is perhaps only one symptom of inappropriate disciplinary methods on the part of the parents of children in the problem group.

The relative popularity of the various food groups may be seen in table 3 which shows the percentages of offered items in each attitude category by food groups. For the combined groups of children, cereals, eggs and vegetables were the least liked food groups while fruits were most liked, followed closely by meats, desserts and dairy foods. Inspection of the percentages falling in each attitude category for the two groups for each food item did not reveal any possible generalization regarding differences between the two groups in the kinds of food preferred.

A marked tendency toward fewer likes and more dislikes in the problem group appears on almost all food items listed. All but nine items were liked by a greater percentage of the non-problem group than of the problem group. Five of these reversals were differences of less than 5 per cent. Most of the differences in favor of the non-problem group were appreciable, and even with the small numbers of cases involved here, are probably significant, many exceeding 20 per cent and several of them being as great as 50 or 60 per cent.

The individual items again show clear differentiation between the two groups in the percentages of children in each group who are indifferent to them, there being much more indifference among the problem children. Reversals in this trend occur on eleven of the seventy-two items. The dislikes and refusals, as already indicated, were infrequent and scattered in both groups. In all but 12 of the 72 items, however, dislikes were more frequent among the problem children. In the refusal category, only 8 items showed reversals of the general tendency toward more refusals among the problem group.

TABLE 3

Percentage of offered items in each attitude category by food groups

	LIKE			INDIFFERENT			DISLIKE			REFUSE		
	NP	FP	All	NP	FP	All	NP	FP	All	NP	FP	All
Breads	86	64	80	13	33	19	1	1	1	0	1	1
Cereals	80	58	71	14	30	19	2	9	5	3	11	6
Desserts	92	68	85	7	20	11	1	7	3	1	5	2
Eggs	74	60	70	18	16	18	1	2	1	7	22	11
Fruits	92	76	88	6	16	9	1	2	1	1	5	2
Meats	90	73	85	10	21	13	0	0	0	1	5	2
Dairy Foods	89	74	84	3	13	7	3	10	5	4	3	4
Vegetables	75	63	71	16	19	17	6	8	6	4	10	6

C. *Relationships of attitudes to age.* Rank order correlations computed between age and the percentage of offered items falling in each of the

attitude categories are shown in table 4. For the group as a whole there appears to be a growing indifference to foods with increase in age (rho = .52) possibly indicative of a general dulling of appetite or of a tendency for older children to express their indifference toward food more freely. There are low negative correlations between age and the percentages of offered foods that are liked, disliked and refused by the group as a whole. The 4 correlations considered together seem to indicate a tendency away from strong preferences and strong aversions with increase in age, and a growing indifference toward food in general. These trends are more striking in the feeding problem group where a correlation of .81 is found between indifference and age as compared with only .32 for the non-problem group. For the problem group, the negative correlation between percentage of liked items and age is much more marked (rho = −.51) than in the non-problem group where it is only −.10. For refusals, the correlations are −.31 and −.02 for the two groups respectively. It cannot be determined from the data at hand whether the cumulative physiological effect of the types of feeding practices prevalent in the problem group noted above might result in this growing attitude of indifference, but investigation of this matter from the physiological point of view should prove fruitful.

TABLE 4

Rank order correlations between age and attitudes toward food

PER CENT OF OFFERED ITEMS THAT ARE	NON-PROBLEM GROUP	PROBLEM GROUP	ALL
Liked	−.10	−.51	−.22
Indifferent	.32	.81	.52
Disliked	−.14	−.07	−.16
Refused	−.02	−.31	−.11

D. *Relation of child's food aversions to aversions in the family.* It is frequently implied, particularly in the clinical literature, that children's food dislikes have their origin in the example and suggestion of other members of the family, especially those of parents and of older siblings. These implications are usually based on the generally admitted power of suggestion and example, and on the citation of isolated instances of identical dislikes among members of the same family. While the data of the present study are rather meagre, they offer some suggestive evidence on the frequency of identical food dislikes on the part of children and members of their families, particularly on the relative frequencies of identical child-parent and of identical child-sibling food aversions.

Because of the small number of dislikes and refusals throughout the data, these two categories have been combined for purposes of this analysis, the results of which are shown in table 5. It appears that the mean number of dislikes plus refusals among the feeding problem cases is over twice as great as among the non-problem cases. It will be seen, however, that there are on the average slightly fewer dislikes and refusals among members of the families of the feeding problem group than in the families of the non-problem group. This difference, while not large, is interesting in that it is in the reverse of the direction that would be expected if example of others

were the principal cause of food dislikes in the problem group. The problem group then, is not characterized by poorer eating habits in the family as measured by the number of aversions here revealed.

It may also be seen from table 5 that the dislike of a certain food by some member of the family is apparently a rather frequent reason for its not being offered to the child. There is a tendency for those items not offered to parallel the mother's dislikes more closely than those of the father or siblings. This tendency to fail to offer children foods which are disliked by someone in the family is nearly twice as great among the non-feeding problem cases as among the feeding problem cases. This may indicate that mothers of the problem cases are more concerned about the diets of their children, or take greater pains to offer variety in order to tempt the children who have poor appetites, or perhaps they more frequently allow substitutions for disliked foods.

In the feeding problem group 47 per cent of the foods disliked or refused by some member of the family, but which were offered to the child, were also disliked or refused by him. The corresponding percentage for the non-problem group is only 27. Children in the feeding problem group liked only 38 per cent of the offered items to which some member of the family had an aversion, while those in the non-problem group liked 57 per cent of such items. It would seem from these comparisons that family food aversions probably have a rather strong influence, and that they are more likely to have an adverse influence on the eating habits of children in the problem group. The two groups

TABLE 5

Various relationships between child and family food aversions

	NON-PROBLEM GROUP	PROBLEM GROUP	ALL
Mean number dislikes plus refusals per child	3.3	8.4	4.8
Mean number family dislikes plus refusals per child	7.2	6.4	7.0
Per cent of items D or R by family not offered child	32	17	28
Per cent of items D or R by family but offered child			
Which are also D or R by child	27	47	33
To which child is indifferent	16	15	15
Which child likes	57	38	52
Per cent of items D or R by child which are:			
Also D or R by someone in family	41	30	35
Not D or R by anyone in family	59	70	65
Per cent of items which child D or R in common with someone in the family that are in common with:			
Adults but not with sibs (only children omitted)	27	21	24
Sibs but not with adults (only children omitted)	73	70	76
Per cent of items which child likes which are D or R by someone in the family	6	5	5

were indifferent to about the same percentage (15 per cent) of the items disliked or refused by others in the family. It would be interesting to know how many of these so-called indifferences are the beginnings of real aversions, and to what extent the failure to like these items is determined by the unfavorable attitude of others toward them. The group as a whole liked about one-half of the offered foods disliked by someone in the family, disliked or refused about one-third of them, and were indifferent to the remainder.

A further analysis of these data was undertaken using the total number of child dislikes plus refusals as 100 per cent instead of the number of family aversions as in the above analysis. This treatment revealed that in the problem group 30 per cent of the child's food aversions are paralleled by identical aversions on the part of some member of the family, while the corresponding percentage for the non-problem group was 41. In the problem group, 70 per cent of the items disliked by the children were not accompanied by similar aversions in the family, while only 59 per cent of the items were not so accompanied in the non-problem group. These figures indicate that children in the problem group had more dislikes and refusals that were unique or peculiar to them, and which were not attributable to the attitudes of others in the family, than did those in the non-problem group. Considering the combined groups, it appears that about one-third of the children's food aversions are identical with, and may conceivably be due to, those of someone in the family, and that two-thirds of them must be attributed to other factors than the example of the eating habits of members of the family.

Another question of interest in this analysis is whether children are more likely to be influenced in their food preferences and aversions by their parents and other adults in the household or by their siblings. Since about one-third of each group were only children or had only infant siblings, and hence could not have any identical child-sibling food aversions, these cases were omitted in this analysis. For the remaining cases it was found, as shown in table 5, that only 24 per cent of the items which the child dislikes in common with some member of the family are identical with the dislikes of adults only, and that 76 per cent of them are identical with the aversions of siblings. The proportions of identical child-adult and identical child-sibling aversions are about equal in the two groups of subjects. These data indicate a rather marked tendency for children to be influenced in their attitudes toward food more strongly by other children than by adults in the family.

This finding of more frequent identical food dislikes among siblings than between child and adult members of the same household is in harmony with the finding of Jones (2) that social imitation is most effective among individuals of similar ages. It is probably also one of the major reasons for the rather uniformly high degree of success of nursery schools in dealing with feeding problems, since they represent a situation in which opportunity for favorable example in eating

habits is afforded from other children of similar age.

SUMMARY

While the following conclusions hold only within the admitted limitations of this study, they may be summarized here as suggestive trends evidenced by the above analyses.

1. The feeding practices in the group of feeding problem cases differed strikingly from those in the non-feeding problem cases, the former receiving greater variety of foods and being offered many of the carbohydrate foods in larger percentages of cases than the latter. Parallel with this is the more restricted use of eggs and of fruits in the feeding problem group, the latter usually being considered more laxative and more stimulating to the appetite.

2. The problem group showed a much lower percentage of liked foods, and a much higher percentage of foods to which they were indifferent and which they disliked or refused than did the non-problem group. These differences in attitude in the two groups appeared not only for the total list and for the major food categories, but on an overwhelming majority of individual food items as well.

3. No significant generalization seems possible regarding the kinds of food preferred by the two groups.

4. Correlations with age indicate a growing indifference to food in general and a tendency away from strong likes and strong aversions with increase in age, this trend being much more evident in the problem group than in the non-problem group.

5. Food aversions on the part of members of the family are associated with about 35 per cent of children's food aversions. The problem group showed greater similarity to the attitudes of others than the non-problem group although they had no more unfavorable example set them. In addition they had a larger number of aversions that were unique or peculiar to them.

6. There was a much higher percentage of identical food aversions among siblings than between children and parents in both groups.

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A Research in Adolescence

The Social World of the Adolescent[1]

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WE REPORT in this article an attempt to understand the social life and development of the boy as he passes from pre-puberty to post-pubescence by studying the activities in which he engages at successive age levels from twelve to sixteen. An objective picture of the adolescent's social world was secured by enumerating the things he actually does and analyzing the amount of time devoted to them. This procedure is definitely limited in its possibilities, of course. It needs to be supplemented by the kind of information which will illuminate the inner world of the adolescent; his attitudes, motives and desires, his ambitions and frustrations, his conflicts, doubts, and worries.

It is possible, however, to learn something about the characteristic development of the boy during adolescence by observing and recording in systematic fashion what he does and the amount of time he devotes to the various types of activity which enter into his course of living. What a person actually does is certainly an essential part of his life as well as the motives of his conduct or the way he *thinks* or *feels* about what he does. We take it for granted that the sixteen-year-old-boy, in comparison with the twelve-year-old, sleeps less, studies more, and is more likely to do some remunerative work in his out-of-school hours. If we knew in a fairly accurate fashion all of the things which the boy does at sixteen and the amount of time they occupy and then compared these facts with those for the pre-pubescent boy, we would have an objective and enlightening—even though crude—index of what takes place in the maturing of the adolescent. We at least would know more definitely what phases of the wider community environment impinge most directly and most frequently upon the growing boy. Changes in the individual should also be registered or reflected in the changes in his overt behavior.

Through a procedure to be described more fully later we were able to secure a *time-activity analysis* for the boys in the study. A complete account of everything done from morning until night, with the amount

[1] This is the second article in a series, the first of which appeared in the September issue of *Child Development*. The major characteristics of this study of two hundred adolescent boys are outlined in the preceding article.

of time devoted to each activity for a period of a week, was secured annually from each of the two-hundred boys. The resulting data, after being classified, compiled, and analyzed, furnish a sketchy outline of the social life and world of the adolescent boy at successive ages, as reflected in his overt activities.

More specifically, the questions which material in this chapter help to answer on a factual basis include the following: (1) How does the adolescent boy spend his time in the current community? What constitutes a typical week for boys at the various ages from twelve to sixteen? How is their time divided among recreational, school, work, and club activities? (2) What does the distribution of time devoted to the various activities reveal about the boy's social world and development? (3) What are the most important changes in activities and experiences from prepubescence to post-pubescence as indicated by changes in the disposition of time? Does the older adolescent boy spend less, or more time in physical play, club activities, reading, study, amusements, etc.? (4) At what age do the most marked changes in social activities as registered in the amount of time devoted to them seem to take place? (5) Is there an overcrowding of the time of the adolescent boy and an overlapping of the agencies which seek his leisure-time loyalty?

TECHNIQUE OF THE TIME-ACTIVITY ANALYSIS

The technique employed for securing the desired information was a combination questionnaire—interview. Some studies had used a questionnaire schedule on which the subjects recorded their activities daily for a period of a week. We doubted the desirability of using this device, as a more adequate control of the reporting process seemed essential for our purpose. It would have been desirable to have the boys report daily to the field workers and fill out a schedule for the preceding twenty-four hours, but this was impracticable.

The procedure finally adopted and utilized throughout the study was as follows. The field workers secured from each boy in the study through an interview, on a carefully prepared schedule, a complete record of: (1) all of the things done by the boy each day for a week from rising until retiring; (2) the amount of time spent in each activity; (3) the persons with whom he engaged in each of these activities; and (4) a list of the boys he knew best ranked in the order of his preference for them. This companionship material provides the basic data for articles to appear later.

A great deal of thought and preparation was required on the part of the field workers to motivate the interview so that the boys would respond with the fullest confidence, coöperation, and frankness. In the course of the three years, in which approximately six hundred interviews took place, very little evidence of irresponsible or uncoöperative attitudes was discernible.

The difficulty of the boy being able to recall his activities for an entire week with accuracy and completeness was fully recognized. Two systems of securing the report from the

boys were tried out in order to determine the better procedure. In the first one, the boy was requested to start a week back and report his activities daily for the intervening period. In the second plan, the boy started with the activities of the preceding day, or the same day if the interview took place at night, and worked backward day by day. The second procedure was distinctly superior in the judgment of the interviewers and their opinion was supported by a comparative study of the filled-in schedules. When the first procedure was used the boys had considerable difficulty in recalling with accuracy and detail the activities of the earlier days in the week period. Consequently the records for these days tended to be more fragmentary. When the procedure was reversed, the more recent experiences of the boys were readily recalled and these tended to stimulate the recall of activities of the preceding day.

A few additional comments about the interview technique may help to answer some of the questions which readers are likely to raise. The interviewer recorded the information himself, partly for purposes of legibility, uniformity, and economy of time, but more particularly to be able to control inconspicuously the completeness and consistency of the report. The interviewer also attempted to get a check on the typicalness of the week reported. For example, if the boy reported attending two movies in the week a question as to whether this was the usual thing or not would secure an answer that would help to correct any marked discrepancies from the customary activity. Immediately after the interview, which usually occupied more than an hour, the interviewer recorded on a part of the schedule provided for this particular purpose his judgment about: (1) the accuracy of the information received; (2) the typicalness of the week reported, and any important deviations from the boy's usual program; (3) the boy's reactions to, and behavior during the interview; and (4) "leads" for further study. This additional information was not only valuable as part of the *time-activity study* but contributed some valuable material toward the more complete case study of each boy.

These comments on the interviewing and recording procedure are the more important because the reliability of this technique was not determined as it would be for a standardized test. There did not seem to be any simple way to establish the reliability of such an instrument. The dependability of the data rests largely, therefore, upon the precautions taken to secure accurate information and upon the evidence of consistency within the material of each interview. An additional check-up on reliability is the extent to which the total results correspond to observation at points where it is most likely to be trustworthy. For illustration, it is a matter of common knowledge that boys sleep less as they get older. The results of the *time-activity schedule* agree so thoroughly with the commonsense expectations that they give indirect evidence of the reliability of the procedure. This kind of evidence is precarious of course. Some of the

results run counter to common expectations but we infer that these findings are essentially reliable even when they contradict common belief. If the *time-activity schedule* is not interpreted as a test but as an interview technique as described, yielding rough data, we feel justified in believing that to sixteen years are shown. Table 2 presents the same facts but on the basis of per cent of time rather than amount of time. A few of the activity categories may need to be defined before the meaning of the results can be most readily grasped. The category *reading* is used for voluntary

TABLE 1

Average hours per week spent in various activities by boys twelve to sixteen years old

ACTIVITY	AGE					CHANGE FROM 12 TO 16 YRS.
	12	13	14	15	16	
	Number of boys					
	30	61	83	53	22	
I: Home activities:						
1. Sleep	74.1	72.0	70.2	68.7	69.2	−4.9
2. Eating	8.8	8.3	7.4	7.1	6.8	−2.0
3. Reading	6.2	5.4	6.5	6.2	5.0	−1.2
4. Entertainment	5.4	7.3	5.5	6.0	6.5	+1.1
5. Chores	2.7	3.3	3.4	3.0	2.5	−0.2
6. Routine	2.6	2.9	2.8	2.9	2.8	+0.2
7. Study	1.3	2.5	2.9	4.1	4.8	+3.5
8. Miscellaneous	3.0	2.5	2.3	2.3	2.0	−1.0
II. Community activities:						
1. Classes	24.1	24.7	24.2	26.5	26.3	+2.2
2. Physical play—participant	10.5	9.6	7.7	6.9	6.7	−3.8
3. Travel	9.6	10.1	10.2	11.4	12.5	+2.0
4. Amusements	6.8	5.0	7.5	6.8	6.0	−0.8
5. Work	3.3	2.7	3.0	4.8	5.2	+1.9
6. Physical play—spectator	0.7	1.2	1.4	1.1	2.0	+1.3
7. Club	2.0	1.7	1.5	0.7	0.2	−1.8
8. Miscellaneous	7.2	7.8	10.2	9.4	9.5	+2.3
Total	168.3	167.9	167.6	167.9	168.0	

the results in general show trends which may be relied upon.

THE ACTIVITY WORLD OF BOYS TWELVE TO SIXTEEN

Table 1 tells a comprehensive and illuminating story. The average hours per week spent in various activities by boys at each age from twelve reading only, as reading done in relation to school work is classified under *study*. Entertainment includes the things of an amusement nature, apart from reading, which are done in the home, such as card playing and listening to the radio. Riding with parents in an automobile is arbitrarily included in this category. Under

routine we have included such items as dressing and washing. *Participating in physical play* is separated from being a *spectator* of sports and games in order that these two quite different sorts of activities could be studied independently. Under *amusements* were grouped all of the extra-home amusements except the physical activities which were participated in or watched. *Club* activities were excluded from this category chiefly because we wanted to observe them as a distinct kind of leisure-time activity. The *travel* category covers all of the time taken in going to and coming from school, work, amusements, etc. The *miscellaneous* category, both in the home and the community lists, really covers everything that did not belong in any of the other categories. In the home it includes such things as: practicing or playing music, just chatting, working on a hobby interest, etc. Similarly, in the community it takes in a variety of things, such as chatting, visiting, attending Sunday school or church, etc.

The facts represented in tables 1 and 2 and the figures which follow throw valuable light on what boys do in a typical week at various ages and on the major shifts which take place in this activity world from the years twelve to sixteen. We shall look first at the typical activity world of the boy at different age levels as revealed by these results.

TABLE 2

Percentage of time per week spent in various activities by boys twelve to sixteen years old

ACTIVITY	AGE					CHANGE FROM 12 TO 16 YRS.
	12	13	14	15	16	
Sleep	44.3	42.0	42.0	42.0	42.3	−2.0
Classes	14.4	14.7	14.4	15.8	15.8	+1.4
Participant in physical play	6.3	5.8	4.0	4.1	4.0	−2.3
Travel	5.7	6.0	6.1	6.8	7.5	+1.8
Eating	5.0	5.0	4.5	4.2	4.3	−0.7
Miscellaneous—community	4.3	4.0	6.1	5.6	5.7	+1.4
Reading	3.7	3.3	3.9	3.7	3.0	−0.7
Amusement—community	4.1	3.5	4.5	4.1	3.6	−0.5
Entertainment—home	3.2	4.3	3.3	3.6	3.9	+0.7
Work	2.0	1.6	2.3	2.9	3.1	+1.1
Chores	1.6	2.0	2.0	1.8	1.5	−0.1
Routine	1.5	1.7	1.7	1.7	1.6	+0.1
Miscellaneous—home	1.5	1.5	1.4	1.4	1.2	−0.3
Club	1.5	1.0	0.9	0.4	0.1	−1.4
Study	0.8	1.5	1.7	2.4	2.9	+2.1
Spectator of physical play	0.4	0.7	0.8	0.7	1.2	+0.8

Typical Week of the Twelve-Year-Old

Fifty-nine per cent of the twelve-year-old boy's week is taken up with sleep and classes, leaving considerably less than half of the boy's week for leisure-time activity. The very small

amount of time spent in study and in club activities may be surprising to some. When the time devoted to entertainment in the home, to amusements outside of the home, and to physical play as participant and spectator are added together we find that over twenty-three hours per week are utilized for purely recreational purposes. This just balances nicely the amount of time spent in school. If we add the six hours per week used in reading "just for fun," over 30 per cent of the boy's waking hours are spent in these four types of recreational activity.

A day's program of activities taken directly from an interview schedule has the value of being concrete, though it may not be very illuminating. We reproduce it, however, chiefly because it illustrates the technique of the *time-activity schedule* better than any explanation could do. The day's schedule which appears below is a typical one. It is reproduced just as it appears on the record without any editorial polishing except the obscuring of names.

Sample of a Day's Activity Schedule for Twelve-Year-Old Boy

Day	*What did you do?*	*With whom?*
Wednesday		
7:30– 8:00	Breakfast—Read Ted Scott—*Flying Against Time*	Nobody
8:00– 8:30	Played football	Named 8 boys
8:30–10:15	Classes at School	38 boys and girls
10:15–10:30	Recess—Played Pom Pom Pullaway	Same boys as for football
10:30–12:15	Classes at School	Same 38 boys and girls
12:15–12:30	Walked Home	Charlie S.
12:30– 1:00	Had Dinner—Read—*Beasts of Tarzan*	Mother
1:00– 1:30	Played football	Same 8 boys as above
1:30– 3:30	Classes at School	Same 38 boys and girls
3:30– 4:30	Played—Chasing a kid who called names	I. S. and B. M.
4:30– 5:00	Ransacked two of dad's old desks, getting clips, etc.	Alone
5:00– 6:30	Supper	Mother, dad, two brothers, 16 and 19, two sisters, 20 and 7
6:30– 7:00	Read—*On the Trail of Washington*	Alone
7:00– 8:45	Went to Library	H. R. and D. W.
8:45– 9:00	Read—*Pirate*	Alone
9:00	Went to bed.	

In studying and interpreting these findings concerning the activities of the boys, a most significant fact should not be overlooked or minimized. In the main we have used averages in the figures because we are seeking major tendencies and generalizations. But there are two very important limitations in using averages. First, the average is an abstraction; there are no actual individuals who correspond to it. Secondly, the use of averages tends to mask individual differences. The exceptions to average trends are also important, both in themselves

and as a source of investigation and discovery.

With this statement about the significance of the variations from the abstract average we shall proceed by describing a typical week of a synthetic twelve-year-old boy in concrete fashion. We recognize, of course, that no individual boy will actually fit the "synthetic" picture, from the standpoint of either the particular, or the diversity of, activities included in the synthesis.

On school days our "synthetic" twelve-year-old gets up about seven or seven-thirty in the morning. He may read, practice his music, or play outside for a while before breakfast. He walks to school, unless he is one of the few who attend high school, when it may be necessary for him to ride. He usually walks with one or more of his boy friends who live near him. At recess he probably plays whatever athletic game is seasonal or some more informal type of game. He walks home at noon, hastily eats, and either reads for a little while, or hurries back to school, generally to get in a half hour of active physical play before classes begin again.

After school the activities of our "synthetic" boy are so diverse that they are hard to put together. About half of the boys play until the evening meal. About twenty-five per cent of them do some kind of remunerative work, delivering newspapers being the most common. Many of the boys spend this time in taking or practicing music lessons, reading, working on some hobby, or "just fooling around." After the evening meal with the family there is likely to be another period of play out-of-doors, either of the seasonal variety of sport, or of such informal games as chase, tag, and hide. The rest of the evening is usually spent at home, reading books, newspapers or magazines, or in some form of entertainment, as listening to the radio. Little time is spent on school work at home. Forty per cent of the boys report no time at all spent on home study, but a few average nearly an hour a day. This is less a matter of age, of course, than of the requirements set by the boy's particular grade in school. A small per cent of the boys attend movies occasionally through the week, but for the majority Saturday or Sunday are the movie days. Two-thirds of the boys belong to some type of club for boys, Scouts, Church, or Y.M.C.A. For them, there is one evening meeting a week, more often on Friday than any other night. We may interject here that two years later, only 25 per cent of these same boys report any club activities whatever in their week's schedule. Bed comes anywhere from nine to ten o'clock.

The week-end program, on Saturdays and Sundays, varies greatly with the boys. Saturday morning typically seems to include a later sleep than usual, whatever chores or errands are to be done, and a little time for play or reading. In the afternoon, more play with the fellows, perhaps a movie, visiting back and forth with friends, some work on achievement tests for Scouts, or perhaps a hike or other activity with the troop or club. Saturday evening may bring a car ride with the family, or a

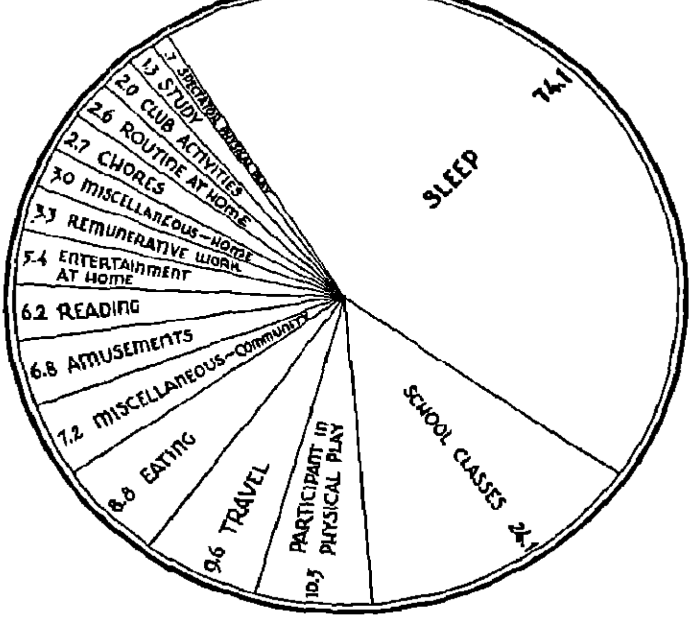

FIG. 1. AVERAGE HOURS PER WEEK SPENT IN VARIOUS ACTIVITIES BY TWELVE-YEAR-OLD BOYS

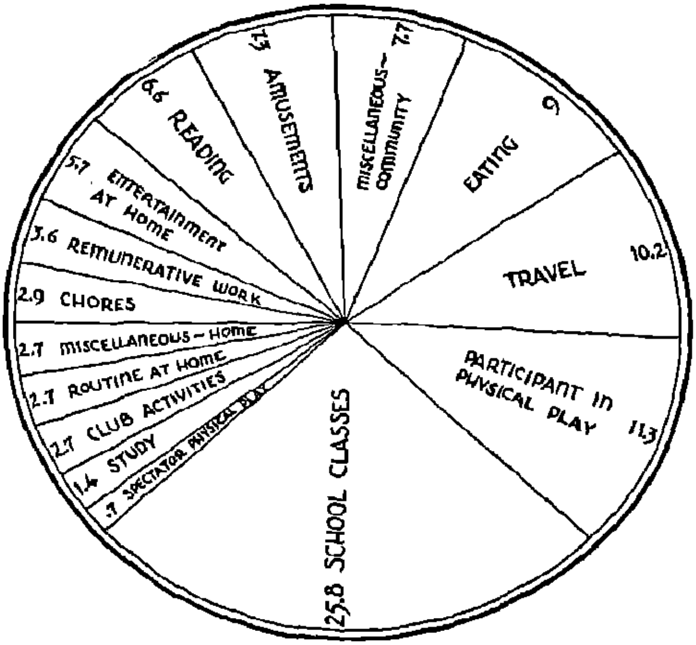

FIG. 2. PERCENTAGE OF TIME PER WEEK SPENT IN VARIOUS ACTIVITIES BY TWELVE-YEAR-OLD BOYS (EXCLUSIVE OF SLEEP)

movie, or more play with the crowd, or possibly the time is spent at home with the radio or in reading. Comes another late sleep on Sunday, then Sunday School for more than half of the boys and church service for a few. Reading the Sunday paper, especially the "funnies," is a general practice. Many of the boys also get in some play with their friends in the morning. In the afternoon and evening there may be a visit from, or to, friends or relatives, often a car ride, but more often a movie.

Such a description of the "synthetic" twelve-year-old may do little more than provide a factual basis for impressions and knowledge which are commonplace to the observers of boys. It gives us only the skeleton of the social world of the twelve-year-old. But it does show us the framework of activity and experience within which the development of the adolescent personality takes place.

Figures 1 and 2 show in graphic manner the time devoted to the various categories of experience at the age of twelve. Figure 1 is based on the average hours per week spent in the activities, figure 2 is based on the percentage of time per week spent in the activities.

Typical Week of "Synthetic" Sixteen-Year-Old

We shall now attempt to portray in descriptive fashion the social world of the "synthetic" sixteen-year-old boy. We can perhaps accomplish this task with more brevity and discrimination if we indicate particularly the points at which it differs most from the activity world of the boy of twelve previously described. Later we shall present in graphic style the data indicating quantitatively the shifts in activity from the twelve- to the sixteen-year level.

The sixteen-year-old boy gets up a little earlier than the younger boy, chiefly because he has farther to go to school. Like the twelve-year-old boy he arrives at school early enough to play, watch others play, chat, or study for a little while before classes begin. At recess he is more likely than the younger boy to be found around the halls or outside talking or "fooling around" with some girls along with some other boys. After school he is a little more likely than the twelve-year-old to have some remunerative job such as selling or delivering papers. If not, he may stay around school to play football, basketball, or baseball, or to practice for track athletics, but unless he is "trying out for the team" he is more likely to be found watching the team practice or play. Quite a large number of boys spend some time during the afternoon reading at home, or in listening to the radio.

We find two or three new tendencies in the evening program of the sixteen-year-old. He is more likely to do something outside of the home, play or visit with friends, go to a movie, or go riding in the car. He is much less likely to attend any organized club activity. Unless he is a patrol leader the chances are slight that he will still be a member of a Scout troop. Neither is he likely to attend club meetings at the church or

Y.M.C.A. Many boys generally spend the evening at home, listening to the radio, reading, perhaps playing pool, checkers or ping pong, and quite often studying.

The activities of the sixteen-year-old boy on Saturday and Sunday are not substantially different from those of the pre-adolescent. On Saturday morning he enjoys a late sleep unless he has a paper route or similar responsibility, does a few chores or errands, and plays or reads for a short time. His afternoon program varies in detail with the season, but its general motif is athletic participation for a few, the spectator rôle for many more, and the spectator rôle via the radio for a large number, especially in the football season. Attending movies, usually with one or more boy friends, is also a common Saturday afternoon event. One new feature is occasionally included in the week-end program. That is the mixed "party," which occurs most frequently on Friday or Saturday night. The mixed party, on anything like a regular basis, is still an affair for the minority, however. For the majority, Saturday night means a show; or just hanging around with the crowd; or reading, playing cards or other games, or listening to the radio, at home.

The sixteen-year-old is less likely to attend Sunday school than the younger boy, but somewhat more likely to attend the adult church service. The rest of the day is used for reading, car riding, a "date" for a few boys, movies for many, listening to radio programs, a little study, and visiting or being visited by friends or relatives.

SHIFTS IN THE SOCIAL WORLD FROM TWELVE TO SIXTEEN

What are the most important changes which take place in the social world of the boy between twelve and sixteen years of age as registered in the amount of time devoted to the various kinds of activities? The answer to this question is supplied in

TABLE 3

Change in amount and per cent of time devoted to activities by boys between twelve and sixteen years of age

ACTIVITY	PER CENT OF CHANGE	RANK	AMOUNT OF CHANGE	RANK
Study	+260	1	+3.5	3
Spectator of physical play	+186	2	+1.3	10
Club activities	−90	3	−1.8	9
Miscellaneous—home	−67	4	−1.0	13
Work	+57	5	+1.0	8
Participation in physical play	−36	6	−3.8	2
Miscellaneous—community	+32	7	+2.3	5
Travel	+30	8	+2.0	4
Eating	−23	9	−2.0	7
Entertainment	+20	10	+1.1	12
Reading	−19	11	−1.2	11
Amusements	−12	12	−0.8	14
Classes	+9	13	+2.2	6
Routine	+8	14	+0.2	15.5
Chores	−7	15.5	−0.2	15.5
Sleep	−7	15.5	−4.9	1

Table 3, which shows the changes in both the actual amounts and the per cent of time spent in the various activities from the twelfth to the sixteenth year. We need to be cautious, however, in making judgments about the relative amounts of change in the different activities, since we are not dealing with comparable units.

Obviously it would be meaningless to say that there was four times as much change in the amount of time spent in sleep as in reading, though that is literally true. The units of time involved in these two activities are so disparate that such comparisons are invalid. The use of percentages shown in the first column of the table is probably more valid. The most valid unit of comparison would probably be the standard deviation of each activity. Hartshorne and May give illustrations of its effective use.[1] The chief advantage in utilizing the figure showing the change in actual amount of time is that it is more readily translated into concrete everyday terms. The statement that the boy at sixteen spends three and a half hours a week more in study than the boy of twelve can be quickly visualized in its practical setting. To state that there is an increase of 269 per cent in the amount of time spent in study from the years twelve to sixteen makes comparison with other activity changes possible, though its practical meaning is less obvious. In our further analysis and interpretation of these findings we shall consider both the actual amount and the per cent of change in the time given to the activities.

Table 3 shows, in addition to the actual amount and the per cent of change in the sixteen types of activities, the rank order of the activities on each of these two bases. The difference which results from these two methods of computation are clearly discernible. Of the first five items computed on the basis of per cent of change only one is included in the first five when the actual amount of change is figured.

Some of the more salient findings represented in table 3 merit further comment and interpretation. We shall consider first those activities to which boys devote a larger amount of time as they become older. Figure 3 displays in graphic form the changes

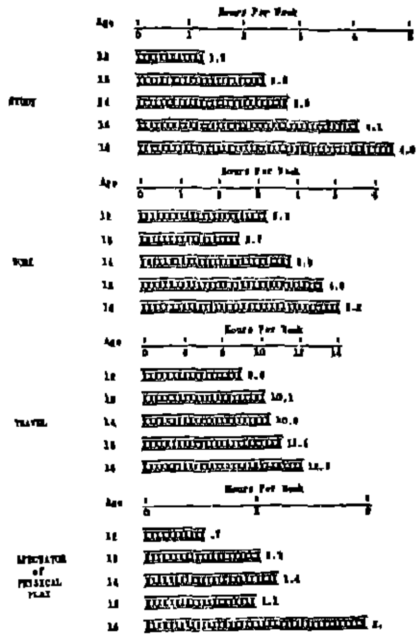

FIG. 3. AVERAGE HOURS PER WEEK SPENT IN STUDY, WORK, TRAVEL AND AS SPECTATOR OF PHYSICAL PLAY, BY BOYS TWELVE TO SIXTEEN YEARS OF AGE

year by year for the five years for some of these activities.

The increased time spent in study, travel, classes, and work is not in the least surprising. The sixteen-year-old boy spends almost four times as many hours per week in study as the twelve-year-old. This difference, due

to the change from elementary to high school, represents both *more* boys who report study and a *larger* amount of time spent in study. A small number of boys report ten to twelve hours of study a week. Quite a substantial number report eight hours. The average, it will be observed, falls slightly below five. The additional time alloted for travel reflects in part attendance at a high school but also time spent in going to and from work or amusements. The gain in time occupied by remunerative work is chiefly the result of the larger number of boys who engage in some form of work outside of school hours. All of the boys are still going to school in their sixteenth year. The larger amount of time given to miscellaneous activities in the community, about two-and-a-third hours, is the more significant when it is recalled that Sunday school and church attendance, which is included in this category, is considerably reduced by sixteen. The difference in the amount of time spent in routine at home, such as washing and dressing, is so trivial that it is insignificant. Theoretically, we might expect considerable additional time devoted to the improvement of the older boy's personal appearance as an accompaniment of his enhanced interest in girls. But twelve minutes a week would hardly do justice to a single "date."

Our attention is arrested strikingly by the fact that as the boys become older they spend an increasing amount of time as *spectators* of games and sports. If this means that the older boys are actively participating in physical activities themselves, but are also interested in watching others, perhaps more skillful than themselves, play, that is one thing. If it signifies that the older boy is becoming *less* a participant and *more* of a spectator, that means something quite different. Which of these it is we shall shortly consider.

When we examine the data for the activities in which boys spend a decreasing amount of time as they get older we find the obvious confirmed at some points and probably receive some surprises at others. As we would expect, there was a gradual reduction in time for sleep and it may be of interest to note that the number of hours of sleep at each age level measures up to the standards set by the specialists in child health. A greater tendency toward irregularity of sleeping hours as the boys become older was clearly discernible as the data were being tabulated.

The second largest shift in the time devoted to an activity is that spent participating in active physical play. This reduction is due to both a decrease in the number of boys who engage in any physical play and in the amount of participation by other boys. A few of the older boys, particularly those who "made" the school teams, spend considerably more time in these activities but this increase of time is more than offset by the reduced participation of the majority. For twenty-five per cent of the boys participation in active physical play is so slight that it is negligible. When these facts are coupled with those which indicate increase of the spectator rôle, it strongly suggests that the germ of "spectatoritis," the unex-

ercised multitude watching the over-exercised few, is already taking hold during adolescence. The "rah rah" college student who shouts vociferously for the team, and his equivalent, the chronic fan in the community, are evidently in the making in these adolescent years. These findings on participation in physical activities and in club activities might be considerably affected by local conditions.

The diminishing time used for eating may not be a matter of great consequence but it does intrigue us to inquire what it signifies. Does it suggest an *accelerated tempo of life*, with so many things to be done that there is a growing tendency to "grab some food and run"? Or does it *chiefly* mean that most of the noon meals are eaten even more hastily at school than they were at home a few years earlier? This latter possibility could easily account for a share of the two hours difference per week.

To some readers the most surprising and provocative findings reported in this article are those depicted in figure 4, showing the rapid reduction in the amount of time utilized for the activities of organized clubs or groups. Under this caption has been included participation in all such groups as Scout Troops and clubs or classes in churches, Y.M.C.A.'s, or social settlements. It includes, therefore, all of the leisure activities which are sponsored and supervised by any of the social or religious agencies of the community. Only five of the twenty-two sixteen-year-old boys report any club participation. This is a small number on which to base generalizations but the tendency toward reduced participation from twelve to sixteen is seen to be consistent from an examination of the facts displayed in figure 4. These findings might be modified in either direction, of course, by a study of similar data from other communities, since local conditions would very directly modify the extent and

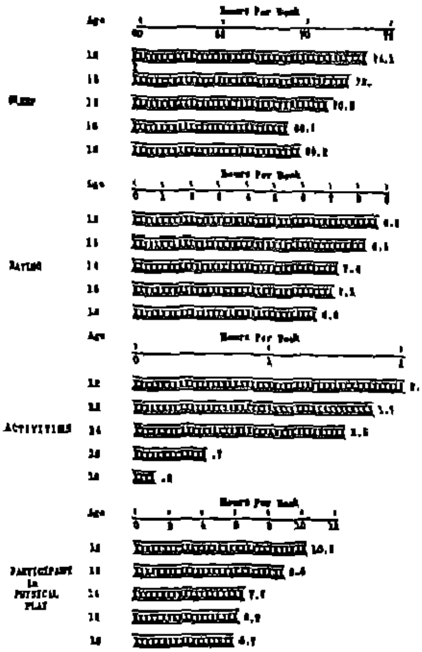

FIG. 4. AVERAGE HOURS PER WEEK SPENT IN SLEEP, EATING, CLUB ACTIVITIES, AND PARTICIPATING IN PHYSICAL PLAY, BY BOYS TWELVE TO SIXTEEN YEARS OF AGE

persistence of membership in organized groups or clubs. In one important way these findings are biased toward a larger participation record. At the beginning of the three-year study nearly all of the boys belonged to groups in one or more of the community agencies, since it was through these agencies that contact with the

boys was established. We might expect, therefore, that their participation in club activities would be *greater* than that of a totally unselected boy population. This enhances the significance of the facts disclosed even though these findings may not be typical of other or all communities in the country.

The implications of the findings on the participation of boys in club activities will be discussed in another place. A few questions, however, will be in order here. Do these facts suggest that the older boy does not need the experience, guidance, and leadership that the community assumes is provided by these agencies which conduct programs specially designed for the adolescent? Or does it mean that these agencies are not providing the kinds of program and leadership which appeal to the older and more difficult-to-satisfy boys? Facts which throw light on this apparent inability of social and religious agencies to hold their participants through the later adolescent years were secured in another phase of the study, which was focused on adolescent groups. One thing does stand out unmistakably. For the boys in this study, there is no problem of multiplicity of social agencies competing for their time and loyalty. A few of the boys belong to two organized groups. But this duplication is negligible even in the earlier years and is practically non-existent by sixteen.

ACTIVITY CHANGES IN RELATION TO AGE

A provocative question now arises. At what age do the most marked activity changes take place as reflected in the shifts in the allocation of time? Does any particular age stand out as a time when the greatest change is taking place? Our facts are too crude to yield anything like satisfactory answers to these questions but we may at least indicate the problems and the techniques which might be applied in dealing with them.

Different approaches to the answer to the question as to what age, if any, reflects the most marked changes are possible. We might ascertain the age at which the *largest number of activities* show the greatest increase or decrease in the time devoted to them. Or we might compute the amount of change in time devoted to all activities for each age period, regardless of whether it is increase or decrease, and assume that the age with the largest "change score" is the most crucial. Both of these analyses have been made.

If we select the eight activities in which change has been most substantially and consistently registered we do not discern any decisive single year period, but the earlier years from twelve to fourteen apparently register more change than any other two-year period. Table 4 indicates that for the one-year periods, five of the eight activities have their greatest change from either twelve to thirteen or from thirteen to fourteen. These differences in many cases are so slight that they are negligible, but the results may at least suggest tendencies.

For the two-year period there is a similar majority of changes in the earlier years, twelve to fourteen. The changes in time devoted to travel and club activities stand out most clearly

after fourteen. The years from twelve to fourteen seem to be more important for changes in: participating in physical play, sleep, eating, and work.

The second type of analysis, the results of which are exhibited in figure 5, shows the total amount of change in

TABLE 4

Ages at which greatest amount of change in hours spent in eight activities takes place

ACTIVITY	ONE YEAR PERIOD	TWO YEAR PERIOD
Participant in physical play	13–14	12–14
Sleep	12–13	12–14
Eating	13–14	12–14
Study	12–13	12–14
	14–15	13–15
Travel	14–15	14–16
Work	13–14	13–15
Spectator of physical play	15–16	12–14
Club	14–15	14–16

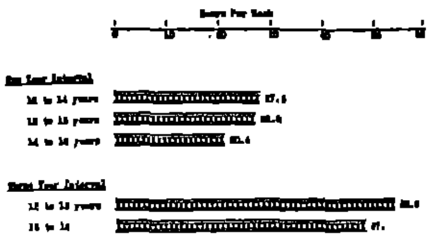

FIG. 5. TOTAL CHANGE IN HOURS PER WEEK SPENT IN ALL ACTIVITIES FOR VARIOUS AGE PERIODS

time allocation for all activities for the different year periods. The total is slightly, but insignificantly, larger for the thirteen-fourteen year period. The changes from fifteen to sixteen are substantially less marked than for any other year period. This difference is largely responsible for the periods fourteen to sixteen and thirteen to sixteen showing the least change of any of the two and three-year periods.

The major interpretation that these facts suggest is that the years twelve to fifteen consistently register more change in the development of the adolescent, as studied by this method, than does the year after the boy is fifteen. Any opinion as to whether pubescent or social factors are the most influential in these changes would be purely speculative in the absence of more accurate and detailed information. A more exact time record for a much larger number of cases, with both pubescent and social factors thoroughly analyzed, might yield fruitful evidence bearing on this problem. In the next article in this series this type of analysis of facts somewhat similar to those presented in this article will be made.

IMPLICATIONS FOR UNDERSTANDING THE DEVELOPMENT OF THE ADOLESCENT

What do all of the foregoing facts mean for our understanding of the personality and social development of the boy during the adolescent years? Our interpretative comments may be summarized around three phases of the adolescent's development. (1) The expansion of social contacts; (2) the achievement of emancipation from parents; (3) heterosexual development.

The Expansion of Social Contacts

Observation might lead us to believe that a major, if not *the* most influential, factor in the development of the adolescent is the widening of social

contacts. *Theoretically, at least,* it is possible to see how many changes in attitudes, interests, and behavior are conditioned by the wider and more complex set of social experiences which gradually impinge upon the boy as he gets older. Social psychologists have believed that many of the assumed characteristics of the adolescent—the new stimulus to thinking, the sharpening of moral discrimination, the conflicts in attitudes and in ideas, etc.—are primarily the result of this broader and more complex set of social factors. The wider social environment brings many contrasts to the ideas, patterns, standards, customs, and mores of childhood, and thus sets the stage for discrimination, choice, conflict, and instability.

Our concern at this point is not so much the effect of such an expanding social world upon the boy as it is the *fact and the extent* of such an expansion. What evidence comes from the analysis of the time-activity data to support or controvert the common observation that the sixteen-year-old boy's world is larger and less simple than that of the twelve-year-old?

The findings which have been reported here suggest four kinds of experience which are indicative of an expanding social world. These four are: the increase of time spent in travel, work, and miscellaneous activities in the community, and the change from the elementary school to the junior or senior high school. This latter shift usually means association with a more heterogeneous student body from the standpoint of race, socio-economic background, community factors, standards and mores, interests, attitudes, and customs. The high school also provides a wider orientation to problems of a social, scientific, and economic character through different teachers, new subjects in the curriculum, and contact with other students.

The increase of time spent in remunerative work also has implications for the enlargement of the boy's social world. We have not attempted to break down the elements of this work-a-day world in any factual way. We may assume the probability of many new elements entering his experience. There is the contact with persons, standards, values, and methods which belong to the business world. There is likely to be a new necessity or demand for responsibility and dependability. There may be a strict accountability to superiors who operate with a new type of authority and control. Relationships may be impersonal and secondary in contrast with the personal relationships of the school and the intimate relationships of the home. The boy may also find a contrast between the "ideals" he has been taught and the "realities" he now discovers.

Effects similar to these which may accompany the high school and work experience may also result from the increased time spent in travel and in miscellaneous activities in the community. These experiences are probably symptomatic of a gradual expansion and complexification of the adolescent's social world. The contact with many persons, situations, and conditions in the community, perhaps a different neighborhood from the one in which he lives, is likely to

open up not merely a larger, but a complex, if not contradictory, set of social patterns and practices. It is the *heterogeneity* in persons, customs, mores, attitudes, ideas, and behavior that comes with the wider contacts of travel, work, high school, etc., that sets the stage potentially through new stimuli and contrast for conflicts, for new attitudes and ideas, and for conduct that may be characteristic of the adolescent.

Emancipation From Parents

The expanding social world is a very definite factor in the process of the boy becoming emancipated from his parents. The central characteristics of an adult are independence and the ability of self-direction. The adolescent years are of crucial importance in this process of becoming psychologically "weaned" or emancipated from parents so that maturity may be achieved. While data directly bearing on this phase of the adolescent's development will be presented in a later article, our attention should be called here to a few implications of the *time-activity* findings for this problem.

The materials yielded by the *time-activity schedule* reveal several factors which may influence or reflect this process of emancipation from parental control. The widening social contacts are basic, of course. They signify that some areas of experience, at least, are passing more completely out of the control of the parent. Remunerative work, whether undertaken because the boy wants more spending money, or because he wants to be more independent, almost inevitably means more independence and freedom, both in relation to parents and to the many choices and decisions which the boy must make. We have noted that the daily schedule, particularly in the evening hours, is more irregular for the older boy, suggesting greater freedom in his evening programs. The slight decrease in time spent in home chores may be another indication of a changing status for the boy in the home. This exemption may be granted because of the increased time he needs for study and for work. The amount of time which the sixteen-year-old spends in the home is probably not so much smaller than that which the twelve-year-old spends as we might expect. At twelve the boy spends one hundred four hours per week in the home. By sixteen this time has been reduced by four-and-a-half hours. Two factors seem to keep the figure as low as four-and-a-half hours. The boy studies on the average three-and-a-half hours more per week at sixteen than at twelve. Further, the radio, which is a major means of entertainment at all ages, does not take the boy out of the home. Attendance at the movies is not very much more frequent for the older boy, although he probably has more freedom in the choice of *where*, and *with whom*, he goes.

The Achievement of Heterosexuality

Some students of adolescent life believe that the achievement of heterosexuality is equalled in importance as an adolescent characteristic only by the process of becoming emancipated from parents. Heterosexuality means an adult level of sexuality

in which the primary sex interest is in the opposite sex. Heterosexual experience is present on the childhood level, but the final stage in the completion of boy-girl differentiation should be achieved by late adolescence. The word "achieved" is aptly chosen because heterosexual development is not a biological gift, though it should normally receive some impetus from the biological changes of puberty. Nor can it take place in a vacuum. It develops only through relationships with the opposite sex.

The findings from the *time-activity schedule* do not permit any time-accounting for this heterosexual experience. Pertinent data are fragmentary, yet indicative. The schedules show that the recess periods at school are used much less for active play by the older boys and more for walking around the halls and chatting with other boys and girls. This may appear to be a very mild form of heterosexual behavior. It marks, however, the beginning or exploratory stage, which leads to activities which are more selective and intense. The number of definite evening "dates" reported in the interviews are few, even for the older boys, but are double in frequency those reported by the younger boys. We realize that these are very meager facts concerning such an important phase of adolescent development. They may be interpreted merely as "straws which indicate the way the wind is blowing."

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Growth in Social Behavior and Mental Activity after Six Months in Nursery School

HELENA MALLAY

SOCIAL behavior is one of the most important aspects of the development of the preschool child. Mental activity is another. Failure to adjust socially and mentally to the environment seems to be highly correlated with emotional instability and general personality difficulties. At the present time, there is as much reason to believe that engaging in successful social behavior and constructive mental activity will automatically clear up emotional difficulties as that emotional analysis and re-education for emotional stability will result in subsequent social adjustment and adjustment in the sphere of mental activity. For this reason, greater emphasis than heretofore has lately been put on techniques for social adjustment and methods for stimulating constructive use of materials and equipment.

Furthermore, there is a growing interest in the interdependence of mental activity and social behavior in the positive influence exerted by each on the other and research directed along these lines should prove exceedingly valuable. The present paper is but a preliminary step and endeavors to give only raw results showing growth in social behavior and mental activity after six months in nursery school without, at this time, drawing conclusions as to their possible interdependence.

The following data gathered at the Vassar College Nursery School under the direction of Dr. Martha May Reynolds during the year 1933–1934 show the growth in social behavior and mental activity over a six months period in nursery school.

A two hours' observation of each of the 21 children (24 five minute records) was taken—one hour in the Fall during the first three weeks of nursery school and the other in the Spring, six months later. The chronological ages of the children (7 two-year olds, 7 three-year olds, 7 four-year olds) ranged from two years, 0 months to four years, nine months as of October 15, 1933, the midpoint of the first period of observation.

The observation record allowed for a notation of the activity engaged in, the vocalization, and any social contacts made *by* the subject or *to* the subject during the 5 minute observation of him. Records were timed to 10 seconds.

With the data on social contacts, a distinction was made between the amount of time in social contact (any

method used: simple regard, vocalization, direct physical contact, physical contact through materials, parallel activity, or coöperative activity) and the amount of time in *group* contact. A *group* contact was defined as two or more children functionally and spatially together, with some common underlying aim or interest though not necessarily of the overt type. This interrelationship had potentialities for coöperation within the group both along the road toward and in the attaining of the goal. There was a positive feeling among the members and acceptance of each by the others. Such a group may have had destructive aims as regards the rest of society, yet so long as similar aims and mutual interest and aid in attaining a goal were evident, these members were a *group*. Quantitative data as to the time spent in activity with materials and the time spent in *active and constructive* use of materials were available. Average attention spans for materials and for children were easily obtained from each record.

It was found that in the Fall, the subjects spent 41390″ of the 75600″ (maximum possible in the 12 five minute records for each subject) in social contact, *i.e.* 54.7 per cent of their free play time. By the Spring, this figure was raised to 66.9 per cent. Of greater interest, however, was the amount of time spent in *group* contact, accepting and accepted by others socially, one of the aims of nursery school education. This was 22040″ (29.2 per cent) in the Fall and 34940″ (46.2 per cent) in the Spring.

There was an increase from Fall to Spring both in the time spent in social contact and in the time spent in *group* contact. The proportionate success, however, in the maintenance of *group* contacts, *i.e.* the ratio of the amount of time in *group* contact to the amount of time in any social contact, was greater in the Spring than in the Fall, 69.1 per cent as against 53.2 per cent. For example, PG, spending but 760″ in social contact in the Fall, brought this figure up to 1370″ in the Spring—an increase of 610″. While in the Fall only 160″ were in *group* contact, in the Spring it was found that 980″ were in *group* contact—an increase of 820″. That is, increases in the amount of time spent in social contact and the amount of time spent in *group* contact were not proportional, the per cent of success in the Fall, 21.0 per cent, being raised by Spring to 71.5 per cent. In the case of GP, a 350″ rise in time spent in social contact from Fall to Spring was found while a 1430″ increase in time spent in *group* contact was found. Again the increase in *group* contact was proportionately much higher with the result that the per cent of success in social contacts, while 50.4 in the Fall, was 93.4 in the Spring.

Table 1 shows that these results were evident at each of the age levels.

Results of a former study (1) showed that contacts of the following pattern types—*Regard, Vocalization, and Coöperative Activity* (*i.e.* one which included as main elements in the contact, the items, Regard, Vocalization, and Coöperative Activity); *Regard, Vocalization, and Parallel Activity; Regard and Coöperative Activity;* and *Regard and Parallel Activity*—were almost certain to result in successful *group* contacts

while patterns of the following types—*Regard; Regard and Vocalization; Regard and Physical Contact; Regard, Vocalization, and Physical Contact*—were almost certain to result in failure to establish *group* contacts.

an increase in those found "successful" (B) from Fall to Spring. Learning of the techniques of social adjustment had evidently taken place. This was as true with the two-year olds as with the three- and four-year olds.

TABLE 1

Growth in social behavior activity from fall to spring

	2-YEAR OLDS		3-YEAR OLDS		4-YEAR OLDS	
	Fall	Spring	Fall	Spring	Fall	Spring
Per cent time in social contact	32.7	50.4	61.2	66.9	70.3	83.4
Per cent time in group contact	13.9	32.7	31.8	39.0	41.7	66.0
Per cent success in social contact	42.4	64.9	52.0	59.5	50.3	79.2

TABLE 2

Distribution of contacts among the eight pattern types

	TOTAL GROUP		2-YEAR OLDS		3-YEAR OLDS		4-YEAR OLDS	
	Fall	*Spring*	*Fall*	*Spring*	*Fall*	*Spring*	*Fall*	*Spring*
A. Types unsuccessful:								
Regard	431	354	134	87	157	156	140	111
Regard and vocalization	185	193	20	33	63	62	102	98
Regard and physical contact	104	75	45	47	40	20	19	8
Regard, vocalization and physical contact	28	19	4	8	10	5	14	6
Totals	748	641	203	175	270	243	275	223
B. Types successful:								
Regard and parallel activity	78	225	51	72	58	68	69	85
Regard and coöperative activity	13	16	2	1	4	7	7	8
Regard, vocalization, parallel activity	54	66	17	17	11	20	20	29
Regard, vocalization, coöperative activity	18	17	3	2	8	0	7	15
Totals	263	324	73	92	81	95	109	137

Table 2 shows the distribution of initiated contacts among the eight pattern types (mutually exclusive) in the Fall and in the Spring.

In general, for all age levels, there was a decrease in those pattern types found to be "unsuccessful" (A) and

Only 3 of the 21 subjects showed decreases in social adjustment from Fall to Spring. Analysis of the patterns of initiated contacts used by them showed that, in spite of the opportunity to learn by experience, in spite of the direct teaching, their

records showed increases in those pattern types found unsuccessful and decreases in those pattern types found successful. Further analysis of these individual cases would be necessary to explain this atypical result. This point will not be discussed here. Attention was now to be directed only to the fact that growth in successful social behavior was correlated directly with changes in types of contacts made and made unnecessary a great number of separate contacts.

Individual increases from Fall to Spring in the per cent of time in *group* contact, in the case of the other 18 subjects, varied from 4.8 per cent to 50.5 per cent.

Sociability indices (the number of other children contacted by each subject—summing direct and indirect observations) increased markedly from

TABLE 3

	BL, −36 PER CENT SOCIAL ADJUSTMENT		PS, +47 PER CENT SOCIAL ADJUSTMENT	
	Fall	Spring	Fall	Spring
A. Types unsuccessful				
Regard	15	16	25	9
Regard and vocalization	4	2	1	1
Regard and physical contact	8	15	4	0
Regard, vocalization and physical contact	1	1	0	1
Totals	28	34	30	11
B. Types successful				
Regard and parallel activity	7	5	13	18
Regard and coöperative activity	1	0	0	0
Regard, vocalization and parallel activity	1	0	2	4
Regard, vocalization and coöperative activity	0	0	0	0
Totals	9	5	15	22

—increases in those types found successful, decreases in those unsuccessful.

Table 3 gives the analysis of the patterns used by one subject who showed a 36 per cent drop in social adjustment from Fall to Spring and those used by another subject who showed a 47 per cent increase in social adjustment from Fall to Spring. It will be noted that the total number of contacts initiated by PS was less in the Spring than in the Fall. This was due to the fact that the contacts made, proving successful, were prolonged

Fall to Spring. For the two-year olds, the average index was raised from 279.0 to 518.1; for the three-year olds, the average index was raised from 595.0 to 768.4; for the four-year olds, from 880.9 to 1158.4.

From Fall to Spring, it was found (1) that more time was spent in social contact and *group* contact; (2) that proportionately more time was spent in *group* contact; (3) that the redistribution of types of approach used showed increases in those successful and decreases in those unsuccessful,

i.e. evidence that techniques for successful social adjustment had been learned; and (4) that a greater number of children were contacted with resultant practice in adjustment to various types of children.

There arises the question of the relative importance of maturation and learning by experience in social behavior development. It is conceded that in all probability maturation might account primarily for growth in social behavior, *i.e.* in the per cent of free play time spent in social contact and the per cent of free play time spent in *group* contact, for the results found showed increases at the succeeding age levels (table 1). However, maturation alone did not seem to be wholly responsible for the greater proportionate success in the initiation and maintenance of *group* contacts. The two-year olds showed a greater increase from Fall to Spring in the per cent of success in the maintenance of *group* contacts than did the three's and even the four's—22.5 per cent as against 7.5 per cent and 19.9 per cent respectively. Furthermore the per cent of success in the Spring at the two-year level, when their average age was 2 years and 10 months, was greater than that of the three-year olds in the Fall, when their average age was 3 years and 7 months. It would seem that although maturation might set the limits to the extent of social activity, within those limits the proportionate success seemed to be dependent on the learning of the techniques of successful social behavior either by experience (indirect teaching) or through direct teaching. This learning seemed to be as possible and as profitable at the two- as at the four-year level.

In addition to the increase in social contacts by means of which techniques of social adjustment were learned, practised, and firmly established, there were found increases after six months in the *active* use of the materials and equipment provided by means of which constructive mental activity was stimulated.

Results showed that in the Fall, the per cent of free play time spent in activity with materials was 79.5 per cent (81.3, 72.3, and 83.8 respectively for the two-, three-, and four-year olds); in the Spring 85.6 per cent (90.8, 80.5, and 85.4 respectively), *i.e.* about four-fifths of the free play time. However, activity with materials did not necessarily imply that the subject was deriving the full benefit of the equipment. For this, there should be *active* use of such equipment.

Anne's passive sitting on a tricycle, watching the other children could not be rated as complete inactivity with materials though undoubtedly it was not *active and constructive* use of the materials (since Anne was already three years old) such as would afford her practice in learning the controls and skills necessary to ride a tricycle. Henry's random manipulation of cubes, engaging in no constructive activity with them, should be considered, at his advanced age level (three years and ten months), as activity with materials but not *active* use of them through which development in the ideational field might be stimulated.

It was found that in the Fall, 66.6 per cent of the time was spent in *active*

use of materials (65.7, 58.4, and 75.6 for the three age levels respectively) and in the Spring, 79.9 per cent (81.9, 75.1, and 82.7). Each age group, independent of their unequal starts in the Fall were stimulated to reach similar maximum levels, about 80 per cent. At each age level, the equipment on hand is peculiarly fitted for that age level so that the two-year olds reached the same maximum as did the four-year olds with respect to their own equipment. A rise in per cent from the two- to the four-year level was not found as might have occurred if only one set of materials were used for all age levels. The two's then, in all probability, would have been unable to make as wide-spread and profitable use of it as the fours.

Individual increases from Fall to Spring in the *active* use of the equipment varied from 1.1 per cent to 42.1 per cent.

In the Fall, of the 79.5 per cent time spent in activity with materials, 66.6 per cent was in *active* use of them; in the Spring, of the 85.6 per cent, 79.9 per cent. Though a small increase was found in the total amount of time spent in activity with materials, a proportionately larger per cent of this time was spent in *active* use of materials by means of which mental activity was stimulated and mental growth and development fostered.

The importance of attention span in social behavior and mental activity cannot be overly emphasized. It is believed that the attention span for materials and the length of social contacts (*i.e.* attention span for children) are interrelated but, at this point, it is difficult to say in just which way. The results gathered incidentally in this study (not primarily one on attention span) showed increases in attention span after six months in nursery school. Attention spans for materials and attention spans for children (*i.e.* length of social contacts) were studied separately. In the case of materials, at the two-year level, an average attention span of 81″ found in the Fall was increased to 116″ in the Spring; at the three-year level, the 130″ average found was increased to 165″; at the four-year level, the 134″ was increased to 140″. The attention spans for children, as judged by the average lengths of maintained contacts, increased in the six months interval at the two-year level from 33″ to 63″; at the three-year level, from 49″ to 69″; at the four-year level, from 59″ to 98″.

To summarize: Growth in social behavior and mental activity was noticed after six months in nursery school (1) in the greater amount of time spent in social contact and in *group* contact; (2) in the fact that there was learning of the techniques of social adjustment—the using to a greater extent those types of approach found to elicit successful contacts with the result that a proportionately greater number of contacts were *group* contacts in the Spring than in the Fall; (3) in the increase in the number of children contacted affording opportunity for adjustment to various types; (4) in the gains at all age levels in the per cent of time spent in general use and in *active* use of materials provided; (5) in the proportionately greater per cent of time spent in con-

structive use of equipment with resultant skills developed in the motor and ideational fields; and (6) in the increases in attention spans for materials and for children.

It seemed true that the limits for "any social activity" and "any mental activity" might be set by maturation. Yet, within these limits, the proportional increase in "successful social activity" and "constructive mental activity" was as great or greater at the two-year level than that at the three- and four. Furthermore, since the average two-year olds in the Spring (age then 2 years and 10 months) surpassed the performance of the average three-year olds in the Fall (age then 3 years and 7 months) in per cent "successful social behavior" and "constructive mental activity," the conclusion might be drawn that learning by experience carried relatively more weight than maturation in regard to growth in these two fields.

CONCLUSION

Results showed that attendance at the nursery school brought about increases in successful social behavior and constructive mental activity and attention span. This improvement was due in part to maturation and in part to learning by experience (indirect teaching), and direct teaching. The data seemed to show that although maturation might set the limits to the extent of social activity, the success of this social activity—*i.e.* the extent to which the subject found himself accepted into a group was dependent on the techniques used. Two-year olds did use techniques found to be "successful" and, whenever they did, were as successful in their social approaches as were four-year olds. Similarly, a maximum of constructive mental activity with materials and equipment was found at the two- as at the four-year level.

Would it not seem then that learning by experience (*indirect teaching*), and direct *teaching* should be considered as positive factors in the growth and development of the preschool child in the fields of social behavior and mental activity?

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Relaxation and Some Related Factors

An Exploratory Study Made in Five Nursery Units[1]

Dorothy Van Alstyne

DAILY programs in nursery schools have been built primarily on the assumption that we should satisfy the child's needs to be active, to eat, and to sleep. They have been based on a broad general knowledge of the young child's requirements and the experience of nursery school teachers. Only recently has an attempt been made to observe children more closely in group situations and to determine experimentally what might be the optimum conditions for meeting the young child's needs in the daily program of the nursery school.

The relaxation period especially has been a subject of much thought and discussion in the three nursery schools in which this study was undertaken. The teachers and directors were particularly interested in knowing what conditions seem favorable to successful relaxation in children of this age; which of the following factors or combinations of these factors might bring about the best conditions for relaxation: the amount of activity in which the child engaged on the playground or in the playroom, the amount of time spent in outdoor play, or the more immediate effect of music and story periods just preceding relaxation?

Stretching and relaxing exercises are given previous to each relaxation period during the early part of the school year until the children have acquired the habit of relaxing easily. These are renewed as necessary during the year. During the relaxation period the children are placed on a hard surface; *i.e.* on rugs on the floor and the room is darkened. A calm quiet atmosphere is maintained largely by means of the relaxation of the teacher herself. Children whose muscles are tensed are aided to release the tension. The teacher flexes their arms or legs or occasionally exerts a slight pressure as a hand is moved slowly across the surface of the muscles.

The present study grew out of a desire to know whether factors other than those included in the regular procedure might not also be important aids to relaxation. As the study grew, interdependence of other factors was indicated. What was the relation of the quality of the relaxation to the following: the amount of extraneous

[1] The writer wishes to express appreciation to Rose H. Alschuler, Director of the Nursery Schools where this study was made and to Advisots of the Behavior Research Fund who sponsored this study. Among the many persons who coöperated in this study thanks are especially due to Emily Osborne and Helen Oberndorf.

activity in the luncheon period, the approximate amount of food consumed, the time which the child took in going to sleep, and the time spent in sleep? What was the relation of all of these factors to the amount of activity in which the child engaged in the preceding two hours of free play? Were age or sex additional factors? In understanding factors basic to relaxation, are differences due to variations within the same individual more important than differences between individuals?

The only study which deals with the rest period in the nursery school was published in 1932 by Staples (9). No effect of a rest period on the length of nap or the time of falling asleep could be found.

Previous investigations have shown the possibility that sleep is related to the amount of morning activity, the amount of play outdoors, the time of falling asleep (8) and the influence of the adult in charge of the nap period (9). Others, however, have found no relation to the amount of outdoor or indoor play to the amount of noon food consumption (10) or to the presence of other children in the room (6). The physiological drive for sleep has been indicated as the most important influencing factor in one study (6). The amount of activity of young children has been found to show sex differentiations (1) and to be effected by the type of situation in which the child finds himself (4). The amount of outdoor versus indoor play seemed to have little relation to the noon food consumption in the only nursery school study in which it was investigated (10).

GENERAL PLAN OF THE EXPERIMENT

To determine the relationship of the various factors to be studied it was decided to observe the children in five groups for a period of two months (March and May, 1932). Observers were to describe the amount of activity, the quality of the relaxation, and the type of behavior at luncheon by using rating scales as a guide. The approximate amount of food consumed, the time required to go to sleep, and the length of the afternoon nap were also recorded. Music and story periods preceding relaxation were experimentally controlled by distributing them regularly among all groups in relation to type of morning and day of the week. This distribution was made in order to secure comparable data. The indoor and outdoor play periods were likewise distributed in a prescribed order so far as possible. Information was secured from the parents in regard to certain factors in the home program for the twenty-four hours preceding the observations at the nursery school. The children were observed in each program on corresponding days of the week. The official temperature of each morning was also noted.

The subjects studied

The children enrolled in three nursery schools and two junior kindergarten groups, who were present for at least four of the eight observation periods, were the subjects of this investigation. Sixty-five children, 31 boys and 34 girls were finally included in the data. Of the 65 children, 42 remained for the afternoon nap period. The majority of the 65 children were

three and four years of age, although the age range was from $2\frac{1}{2}$ to $5\frac{1}{2}$ years. Nearly all of these children had been enrolled in the schools since the previous September, and some had been members of the group for over a year and a half.

Whatever tendencies may be suggested in this study, they cannot be due to the fact that they represent one situation only, or to the fact that they are the result of the personality of one or two teachers. This study represents an experiment carried on in nursery schools representing different social and economic situations and having as subjects a fairly random sampling of nursery school population, at least before the Emergency Nursery Schools were started. Two of the five nursery units from which the subjects came were the Winnetka Public Schools and three in Chicago. One was the Parker Practice Nursery of Chicago Normal College and two were The Garden Apartments Nursery School for Negro Children.

DESCRIPTIONS OF THE METHODS USED

The rating scales

At the time this study was planned (1932) the rating scales evolved by Sweeney, Hejiman and Sholley (11) seemed to be most helpful in suggesting a possible device for judging activity and relaxation by the rating method. Goodenough's scale (1) also was found helpful in defining some of the gross movements more accurately. Revisions of former scales were made by the present author because of the difficulty of handling nine different scales at once.

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observations of these two judges, rating independently, are high, ranging from +.82 in the case of Luncheon Behavior Scale to +.96 for the Relaxation Period Scale. The correlations for all scales combined was +.90.

Two inexperienced observers X and Y were given the rating scales and asked to make two complete days' observation, using all four scales. No further directions or explanations were given except the method of timing by 15 or 30 second intervals. The correlations of the ratings by Observers X and Y with those by each of the two practiced observers were high, ranging at lowest from +.63 for the Luncheon Behavior Scale to +.90 for the Outdoor Activity Scale.

These correlations with two additional observers may also be said to constitute the validity of the rating scales, according to Thurstone (12).

Method of observation

The rating scale judgments were made by using the method of time sampling units. In the case of the Activity and of the Relaxation Period Scales 15 seconds of observation was the time unit found to be the best basis for judgment, but 30 seconds seemed necessary for the Luncheon Behavior Scale. A stop watch was used, and the two observers made their independent judgments simultaneously on the same child, going from one child to the next until all of the group had been judged and then repeating the process.

Records of luncheon and nap. Records of the approximate amount of food consumed were made by the nursery school teachers as part of the regular routine of the school for the sake of studying individual cases and also for the collection of data for studies to be made by the Elizabeth McCormick Memorial Fund. Although estimates of the approximate amount eaten by the children were made by the teachers in regard to each serving, it was thought possible to secure only a rough measure for the purpose of this study since the servings in each of the groups were likely to vary somewhat with individual needs, different personnel, etc.

The children's records were divided into four sections: (A) Those in which the children ate no luncheon, (B) Those in which the children did not finish the complete meal served (including dessert), (C) Those in which the children ate all of the meal served to them, and (D) Those in which the children ate more than the meal first served to them. Because of the possibility of varying sizes of servings in the four groups, the trends in each group were studied separately as well as in combination.

The afternoon nap records were customarily taken for the same reasons as the food records. The teachers recorded the time the child lay down in his bed, the time at which the child went to sleep (as judged by closed eyes, cessation of movement and regular breathing) and the time at which the child awakened.

Indoor and outdoor play periods. Each of the five groups were observed for eight mornings, making a total of 40 mornings of observation. On 11 of these days the children played indoors all morning, on 15 days during

the two hour free play period they played half indoors and half outdoors and on 14 days they played outdoors all of the time observed.

Music and story periods preceding relaxation. Quiet story periods and active music periods of 15 to 20 minutes each preceding relaxation were distributed in a prearranged order so that each group would have approximately the same number and so that due attention would be paid to the division between indoor, indoor-outdoor, and outdoor mornings. In all of the groups together there were 20 story periods and 20 music periods preceding relaxation. Although the music period largely consisted of activity including rhythmical interpretations of music such as marching, skipping, galloping, etc., as well as singing, clapping hands to music, etc. quiet music was played at the end to make the transition before relaxation.

Type of previous home program. Since the influence of the happenings at home might have a marked effect on the quality of the child's relaxation or activity at school, it was thought interesting to see what could be discovered by considering this phase of the child's program. A questionnaire was accordingly sent home with each child and returned on the morning previous to the observation at the nursery school. The questions were designed to discover whether the child had had his usual program at home, or whether it had been an unusually exciting or stimulating one.

Days of the week. The observations were distributed to allow comparisons between the different days of the week. Each group was observed on five different days of the week during the two four-week periods in which the observations were made. Thus the final number of groups for each of the five days of the week was eight.

Outdoor temperature. The official temperature for ten o'clock for each morning on which the children played outdoors for part or all of the time was noted on each record.

Summary of factors related to relaxation

1. On the whole, the factors studied in the present investigation seemed to have little influence on the relaxation period.

2. When all cases are taken into consideration there is a slightly positive but an insignificant relation between the quality of the relaxation and
   a. Amount of activity during the morning play period.
   b. Location of play activities; *i.e.*, whether outdoor, indoor, or part indoor and part outdoor.
   c. Nature of activities just preceding relaxation; *i.e.*, whether music or story.
   d. A combination of the factors listed above under b and c. (Best combinations seemed to be an indoor-outdoor morning followed by stories and an outdoor morning followed by music.)
   e. "Unusual" factors in the home program.
   f. Extraneous activity at the lunch table.
   g. Amount of food consumed.
   h. Time of falling asleep.
   i. Length of nap.
   j. Day of the week. (Monday and Wednesday seemed poorer days for relaxation, Friday best.)
   k. Temperature. (Warm weather records on outdoor mornings

yielded the better relaxation scores.)

l. Race. (Negroes scored better on relaxation than did whites.)

3. When only extreme cases were studied the following tendencies were noted: (a) The more active children tended to have poorer relaxation periods than the least active, (b) the children who had "external" disturbances in home programs, especially late bed times or illness in the household, relaxed more poorly than the others, (c) children who ate most at lunch tended to relax better than those who ate less, (d) the best relaxed children fell asleep on an average of 7 to 8 minutes sooner than the least relaxed, (e) the best relaxed children slept on an average of eighteen minutes longer than the poorly relaxed.

4. There was apparently no relation between degree of relaxation and age or sex.

Summary of factors related to activity

The findings of the present section indicate, in general, that individual differences are practically as great in the case of activity as they are in the case of relaxation, each within the limits of its own scale. The following tendencies have been noted for the cases as a whole.

There is a slight positive relation between activity in a free play period and location of play activities; amount of food consumed; day of the week; age; and sex. Children seem more active on the days they play outdoors than on indoor mornings or part outdoor part indoor mornings. The more active children tend to eat more. The less activity occurred on Monday and Friday, the most on Tuesday and Wednesday. The younger children were slightly more active than the older, and boys were slightly more active than girls.

There seemed to be little relation between activity in the free play period and temperature within the range studied; quality of relaxation; table behavior; and race.

An examination of extreme cases revealed the following trends: the extremely active took longer to relax than did the extremely inactive; the extremely active took longer to fall asleep and slept longer than did the extremely inactive; and a larger percentage of the most active children had disturbances in their home program.

Summary of factors related to nap

On the whole, the factors studied in the present section appeared to have little influence on the nap period. Individual differences and the factor of sleep habits established by this time of year would appear to be the more important. Among the tendencies which were noted, however, the following deserve mention.

In general, those cases who took longer to fall asleep tended to be children who spent part of the mornings indoors and part outdoors; who played outdoors in warm weather as opposed to cold weather; who ate more than the amount served; and who were observed on Wednesday as opposed to other days of the week.

Those cases who took the shortest time to fall asleep included children who played indoors all morning; who played outdoors on cold mornings; and who were observed on Friday as opposed to other days of the week.

Those cases who slept the shortest

time tended to be children who spent part of the morning indoors, part outdoors; who ate more than the amount served; and who were observed on Wednesdays as opposed to other days.

Those cases which were characterized by the longest sleeping time tended to include children who had played indoors; who had eaten less than the amount served; and who were observed on Tuesdays and Fridays as compared with other days.

When only the extreme cases were studied:

a. A positive relationship was found between length of time taken to fall asleep and high activity, poor relaxation, and an unusual home program.
b. A positive tendency was found for the children taking the least time to fall asleep to have good relaxation and low activity scores.
c. A positive tendency was found for the children sleeping the shortest time to be poor in relaxation and to exhibit a low degree of activity.
d. A positive tendency was found for children who slept longest to have high activity, extremely good relaxation, and an unusual home program.

The average length of the nap for the group as a whole was found to be 89.74. This finding is in close agreement with that of Sherman (8).

INTERPRETATION OF RESULTS

Significance of findings in the study of relaxation

Children in the nursery school at the time of year when this study was made had established habits of relaxation which were apparently little influenced by extraneous factors. No real differences in the degree of relaxation could be found under the varied conditions which were studied, although certain trends indicated the possibility of some slight effect of temperature on the mornings that the children played out of doors, the type of home program, and the day of the week. On the whole, however, the lack of effect or relation was more striking than the reverse.

The study has indicated that individual differences are important factors to consider when judging the quality of a child's relaxation. Through an analysis of individual differences it was found that a consistently high or low degree of activity and extremes in time of going to sleep and length of nap are related to the quality of relaxation. *In other words, if good conditions for* relaxation are provided and previous habits of relaxation have been established, the type of relaxation that will result would seem to depend more on the inherent qualities of the child than on factors in the daily program.

What the inherent basis of these individual differences is can only be a matter of conjecture, but there is a possibility that it is physiological. The nervous, glandular or nutritional constitution of the individual may be a determining factor in the degree of relaxation which he is likely to attain.

In addition to the constitutional make-up of the child, possible home disturbances constitute a factor to be considered. Although there was only a slight tendency for the children with unusual home programs to have a poor quality of relaxation, when the

factors in the unusual programs were analyzed it was indicated that the factors which are external, such as late bed-time and illness in the household, may have a relationship with relaxation at school. Contrary to the usual supposition, the factors in the program which have to do with variations in the child's own behavior such as temper tantrums and sleep disturbances seem to make little difference.

It is perhaps natural for temperature to show some indication of influencing the relaxation period. Heat is used by many physicians to aid in the lessening of tension in their patients who are subject to nervous disorders and a mildly warm bath is sometimes advised for its calming effect. It is possible that even greater differences in the quality of the relaxation period would have been found if the differences in temperatures studied had been greater.

The third factor which should be considered as having some significance in addition to individual variations is that of the day of the week. The tendency for the earlier part of the week to show poor relaxation periods and for Friday to yield a good quality of relaxation may be due to habits of relaxation gradually rebuilt during the week in the regular routine of the nursery school.

In the application of these results to the nursery school situation, it is apparent that there are certain factors which may have seemed important on casual observation but which further study reveals as insignificant for consideration in nursery school programs. The nursery school teacher who wishes to secure the best quality of relaxation for her children, once the habit of relaxation has been established as far as possible by means of the technique described, should feel more free, on the basis of the present study, to overlook a number of factors (such as amount of activity within moderate bounds, or type of activity—*i.e.* music or story period—preceding the relaxation period) and to concentrate on the more obvious factors of temperature, day of the week, and home program.

It is also extremely important for the nursery teacher to recognize the significance of individual differences. Is it, perhaps, a well-nigh physical impossibility for some children to attain the degree of relaxation of which others are capable? Is it possible that individuals who are hyper-active, characteristically disposed to take a long time to fall asleep, have a short nap period, or that those who have a different constitutional make-up may have difficulty in relaxing well? It is necessary for the teacher to decide definitely whether the child's restlessness is a conscious attempt to attract her attention or something which he cannot help before adopting any policy in the matter of inducing relaxation. The treatment would obviously be quite different in the two cases. If the child is seeking attention, the teacher would try to meet the situation with apparent unconcern or possibly isolation. If the restlessness seems unavoidable, it might be well to provide additional relaxation periods, both in the mid-morning at school and in the late afternoon at home.

Significance of findings in the study of children's activity during free play periods in the nursery school

Two trends noted in this section of the study are the tendency for the children when they played out of doors to be more active and for the more active children to consume more food than the inactive. The outdoor playground has large apparatus on which more active play can be performed than indoors, and the greater amount of space allows for more freedom of action. Likewise, the children who are more active are more likely to burn more body fuel and have larger appetites, as many nutritional studies have shown (7).

It was found that in the extreme instances, degree of activity was related to quality of relaxation, length of time taken to fall asleep and length of nap. When we consider the fact that the most active children tended to relax the most poorly, took longest to fall asleep, and tended to sleep longer than the extremely inactive children, there comes to mind the possibility of an underlying factor of nervous tension or other causes in the child's glandular, chemical, or nutritional constitution which may be at the basis of the high degree of activity. Perhaps this extreme activity is really undesirable and a symptom of underlying tension which makes it impossible for the child to relax well and to go to sleep quickly. Due to exhaustion, perhaps, the child sleeps a long time after he once falls to sleep. These assumptions, it should be noted, have only been suggested as possible explanations for the present findings. They are in need of further study.

The above suppositions seem to be somewhat substantiated when we examine the results of the study of home programs. A high degree of activity seems to be related to disturbed home programs, but whether the home programs are the cause of this disproportionate activity or are themselves symptoms of tensions and instability in the household would have to be studied in each case.

In interpreting the curves of activity in relation to the day of the week, one is reminded of similar results found in industry (2); *i.e.*, the lowered activity or "warming-up" period found on Monday, the highest peaks during the week when the workers have "gotten their stride" and the gradual slowing up toward the end of the week. In the case of nursery school children we might consider that the somewhat lowered activity on Monday would be due to the fatigue resulting from a probably different program on Sunday (including difference in time of meals, presence of extra adults, loss of nap or late bed hour), or to the readjustment to the school situation after two days at home. The lowered activity on Friday, coming after the higher level of Tuesday and Wednesday may indicate a somewhat calming effect of a week in the regular routine of the nursery school. The fact that the highest degree of activity is on Wednesday proves interesting in the light of the more frequent judgments by teachers of Wednesday as a "poor" day. The combined results of several other factors in the nursery school day such as relaxation, food consumption, and time of going to sleep also showed Wednesday to be the poorest

day. This relation of the greatest activity to the "worst day" may corroborate the theory that one of the underlying causes of extreme activity is tension. Why Wednesday should present this symptom more than any other day is a matter for conjecture.

It is not surprising that the younger children proved to be slightly the more active, as they are the ones who like the toys requiring more locomotion. Likewise, the older children are usually the ones who become interested for long periods indoors in the sedentary occupations of drawing, cutting, working with clay, etc., and who have a longer attention span in all activities (*13*). *For* practically the same reasons, we would expect the boys to be somewhat more active than the girls, a tendency which was also indicated in this study.

Significance of findings for the nap period

The differences between groups compared on the basis of factors studied in relation to the nap period are insignificant in comparison with individual differences. *It seems apparent that* at the time of year when this study was made the habits of falling asleep after a certain length of time and of sleeping for a certain period had been so established that other factors in the child's program could have little effect.

The same result has been indicated by other studies which have shown *that children tend to sleep approximately* the same length of time regardless of whether curtains are between their beds (5), whether they sleep in groups or alone (6), whether they have had a long outdoor play period, or whether they have had a rest *period previous to luncheon* (*10*). Sherman (8) also states that apparently children of this age acquire a habit of remaining in bed a certain length of time before falling asleep. The only study which showed any one factor as seeming to make a difference in the nap period was that by Staples (9), who found that the personality of the teacher in charge had some effect. The present investigation largely rules out this factor for the findings as a whole since there were four different groups who stayed for nap, each of which was in the charge of at least two teachers.

Careful training in the regular nursery school routine gradually builds up sleep habits and teachers in general expect children to sleep on the average a certain length of time once these habits have been established. Individual differences in time of falling asleep and length of nap are recognized here also as important aspects of the nap situation.

Certain tendencies in the findings of this study suggest that there may be some slight effect on the nap period, perhaps more at the time of establishing sleep habits than later, of such factors as temperature, day of the week, food consumption, and outdoor play, and in extreme cases, of activity of the child in the play period, the quality of his relaxation, and the type of home program. Although these tendencies are very small indeed, they may be found larger if more records are studied.

A study of the day of the week on which there were the worst and best

nap periods is interesting. On the poorest day, Wednesday, there was also the highest activity, poor relaxation, low food consumption. Why this is a poor day can only be surmised. Perhaps it is related to the high degree of activity found on that day. Tuesday as a good nap period may be so because by the second day of the school week the children have become once more adjusted to the school routine. Friday's good record can probably be explained by the gradual reestablishment of good sleep habits built up during the week.

As in the case of relaxation, it is seen that the child who is extremely active in the free play period and who has an unusual and probably "over-stimulated" program at home tends to take longest in falling asleep. Likewise, the most poorly relaxed child takes longest in falling asleep. As previously indicated in the discussion of the relaxation period, there is probably some underlying cause for this, whether of individual make-up or of instability in the home. Both may be present, but which is cause and which effect cannot be analyzed here. At least these findings point again to the marked differences between individuals which all nursery school teachers have learned to recognize.

Interrelation of all factors studied

When all of the types of situations studied in the nursery school program were analyzed for apparent relationships it was found that although children on the whole are not especially consistent in the apparently same situation there does tend to be more consistency in a child's reaction to a certain situation than there is in his behavior in a number of situations. The percentage of children who showed extreme instances more than once ranged from 35 to 70. For instance, if a child is extremely active on the playground on one day we can expect that he will be extremely active on some other day, but the fact that he is extremely active during his play period is no indication that he will be extraneously active and exhibit the best behavior at the lunch table or that he will not relax quickly or that he will take a long time to fall asleep.

Among the extreme cases, children who were best in one type of behavior situation were often worst in another, such as good relaxation and poor behavior at lunch, but children who were best in one type of behavior situation were seldom among the worst in that same situation and children who were in the poorest group were seldom found in the best. The greatest consistency in any one type is found in the length of nap and the least consistency in the degree of activity.

This trend toward consistency of extreme instances within one type of behavior situation and inconsistency among various situations points to the specificity of each of the types of behavior situations studied. In other words, not only is there a wide variety of individual differences but also a considerable variation in each individual's reaction to the type of behavior situation in which he finds himself.

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